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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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The Registered Office and Laboratories of the B.C.I.R.A. are:—
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Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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The Non-Ferrous Foundry Industry

Generally speaking, the non-ferrous foundry industry is not so well catered for from the statistical point of view as iron founding. The statistics available enter into several of the Government publications, but the most illuminating of all is the Fifth Census of Production. Herein 122 separate trades are distinguished, and naturally there is a desire on the part of the Board of Trade not to introduce too much complication. Thus we find the non-ferrous foundry industry is combined with all the other trades allied to it, such as the smelting and rolling of copper, brass, aluminium, lead, tin, gold and silver, brass finishing, plate and jewelry and watch and clock making. The first figure of note to be reported is one for brass castings, and it appears that in 1934, the industry manufactured 22,500 tons of a value of £2,084,000, and in 1935, 24,900 tons valued at £2,427,000. Immediately beneath the table containing these figures there is a second table by way of an appendix, and herein it is shown that the industry bought in 1934 a matter of £45,000 worth of brass castings, and in 1935, £42,000. So far as international business is concerned, there is no specific reference, though the trade in the export of manganese brass propellers is well known.

Appearing in a table headed "Other output of the copper and brass trade," there is an item "manufactures (including [aluminium] castings)" which shows that this section in 1935 made 1,660 tons valued at £278,000. This metal is really dealt with in another section—"The Aluminium, Lead, Tin, etc., Trades" (smelting, rolling, etc.)—and therein the quantity and value of aluminium castings are given for 1935 as 15,300 tons valued at £2,142,000. The corresponding figures for 1934 were 14,900 tons and £1,984,000—a very useful increase in business. Though magnesium castings are not mentioned, the total output of this metal and its alloys was 16,900 cwts. valued at £272,000 in 1935. This section of the industry was also responsible for a certain amount of brass castings and, including ingots, it was in 1935 of the order of 1,500 tons valued at £95,000. Merchants may be interested to learn that the "Aluminium, Lead, etc., Trades" sold as scrap a matter of 80,000 tons of iron and steel.

The final section included in this survey is the "Finished Brass Trade," and hereunder is reported a further sale of brass castings in 1935, the value of which was £216,000 as against £201,000 in 1934. Examining the list of entries under this heading, which reaches the not inconsequential total of nearly £11,000,000, it is obvious that a very serious proportion is actually castings. We do not believe that any useful purpose would be served by making additions of the figures quoted, as we are not at all certain that in some cases subtractions may not be more appropriate, since certain parcels or goods may figure twice. The figures are distinctly useful as indicating trends, and much as we would like the non-ferrous foundry trade to be treated as a separate industry, we realise the very considerable difficulties involved.

Still Upward

The figures of industrial production continue to show an upward trend. Of all the years after the post-war boom had exhausted itself, 1929 was by far the best, and has been a sort of standard whereby other years have been judged. For the first time the output figures for pig-iron have well exceeded those of 1929, taking monthly production as a convenient basis. In 1929 the monthly average production of pig-iron was 0.63 million tons while in 1936, after falling in 1934 to below 0.5 million tons, it was at the same figure as for 1929. For the first seven months of 1937 the figure is well in excess of this, being 0.68 million tons, and the July output was the highest for the year. Steel ingots and castings make an even better showing. In 1929 the output was 0.8 million tons per month while in 1936 the figure began to approach a million tons per month. In 1937 the seven months up to and including July have yielded an average monthly output of over 1.05 million tons. In the absence of any authoritative figures for ironfounding, we feel sure that these figures will be taken as some guide to the position.

The excess of steel output over that of pig-iron once again emphasises the importance of scrap, and two officials of the British Iron & Steel Corporation have begun an air tour of the country to observe the progress of the national scrap campaign, and will have visited about twenty cities in ten days. It is understood that means will be devised to take advantage of voluntary offers to collect scrap through such bodies as the Boy Scouts and British Legion, and to co-ordinate this work with that of the recognised scrap dealers. As we have already pointed out, the scrap brought to light in this way will help to relieve the founding industry generally by partially satisfying the demand for scrap in the steel industry, although whether it is wise to denude the country of hidden reserves of scrap except in a major emergency is open to argument.

District Presidents—No. 2

SCOTTISH BRANCH OF THE I.B.F.

MR. E. J. ROSS, President of the Scottish Branch of the Institute of British Foundrymen, was trained as an engineer and foundryman with Watson, Laidlaw & Company, Limited, Glasgow, John McNeil & Company, Limited, Govan, and at the Royal Technical College, Glasgow. He joined the drawing office staff of G. & J. Weir, Limited, Cathcart, and was for some years engaged on general design. When this company inaugurated the Argus Foundry, Limited, at Thornliebank, near Glasgow, Mr. Ross was transferred to the foundry planning department, where he devoted a number of years to developing methods of moulding, foundry gear and patternmaking for machine moulding, ultimately having charge of this department. Following this, he was for about three years assistant manager at the Argus Foundry, Limited, and two years assistant manager in Messrs. Weirs' Holm Foundry. Since 1932 Mr. Ross has had control of the Argus Foundry, Limited.

MR. E. J. ROSS.

Notes from the Branches

Lancashire Branch.—A visit to the foundries and works of Vickers-Armstrong, Limited, at Barrow-in-Furness, is to take place on Saturday morning, September 18. The party will leave Manchester (Victoria Station, No. 12 platform) on Friday, September 17, at 6.38 p.m., or Preston at 7.35 p.m., or Lancaster at 8.8 p.m., and will arrive in Barrow-in-Furness at 9.41 p.m. Accommodation has been reserved at the Victoria Park Hotel (bed and breakfast), and the party will be conveyed from the hotel to the works at 8.45 a.m. on Saturday. Commander Sir Charles Craven, O.B.E., on behalf of the directors of Vickers-Armstrong, Limited, has kindly invited the party to luncheon at the conclusion of the visit.

A visit in the afternoon to Biggar Bank and the West shore of Walney Island and/or a drive via the coast road, skirting Morecambe Bay, can be arranged, and trains may be rejoined at Ulverston. Those wishing to participate in the visit should apply to Mr. J. E. Cooke, Pendlebury Foundry, Pendlebury, near Manchester, not later than September 4. The inclusive cost per head will be 23s. 6d.

MR. CYRIL WATTS, assistant managing director of Richard Thomas & Company, Limited, has been elected chairman of the board of directors of the London Iron and Steel Exchange, Limited, in succession to the late Mr. James Whitby, who had held that office since the establishment of the Exchange.

Sand Casting Ornamental Bronze Work

For many years the work of Felix Peano in the sand casting of ornamental and decorative bronze work has received wide recognition. In his studio in Hawthorne, California, this artist reproduces the most delicate patterns of flowers and other objects with a fidelity which is amazing. Mr. Peano has revived the process of sand casting bronze which reached its height in the work of Benvenuto Cellini during the Renaissance in Italy.

In Cellini's day wax patterns were buried in sand and then melted out to form the mould. Peano buries the actual flowers, reduces them to ashes by heat-treatment and finally blows out the ashes. Into this mould he pours the molten bronze. Outstanding work of this sculptor who casts his own creations in bronze and copper adorns many private houses and public buildings in America. Our illustration shows a massive bronze door which was designed and sand cast by this artist. The door, which is nearly eight feet high, depicts various well-known passages from the Bible around the border, and in the centre are several figures symbolic of baptism, life and death.

[Courtesy of Copper & Brass Research Association.

SAND-CAST BRONZE DOOR DESIGNED BY FELIX PEANO.

Random Shots

One small country foundry, at least, has been quietly carrying out its own scrap campaign in a way which could well be emulated by others wherever possible Its chief business is making agricultural implements, and as these are delivered to the various farms, any scrap is collected and taken away as part payment.

* * *

"Marksman" visited this particular foundry whilst on holiday, such is his enthusiasm or deep seated habit. The owners are a couple of brave-hearted lads who started on their hazardous venture only six months ago, having spent all their young lives as farmers. They, at any rate, enter the industry with an understanding of the farmer's requirements, and wisely enough, they leave the finer points of practical founding to their skilled moulder. Their apprentice looks like a little black crow ready to pick the brains of his boss, the skilled moulder, very thoroughly. So good luck to them all!

* * *

The language used in our steelworks and machine shops has long been famous for its blueness at times, in fact, at nearly all times, and it is a curious fact that the same tendency is found in the country amongst the farm labourers. The language of the machine shearers of sheep is exceedingly blasphemous compared with that of the hand-shearers. At least, so the farmers say!

* * *

Christmas Island is reported to be starting its own foundry. There surely cannot be room for two, so if anyone else has had the same idea, he had better wait till Easter—Island wants one!

* * *

It is a grave reflection on the industry that the memorial to John Wilkinson has been allowed to fall into disrepair—and a graver trouble, apparently, is in store, when it comes to finding the grave of that grand figure of early foundry history.

* * *

From the search for graves follows a search for knowledge, and firstly one wonders why a foundry at Eaglescliffe should be named Egglescliffe, and secondly if there is not a Long and Short in the industry who could come forth for the Presidency of the Institute in competition with Mr. Little, a deceased President, and Mr. Bigg, this year's President. There is, of course, no Reason why this should not come to pass!

* * *

The latest foundry "hobo" comes from Spain, where his foundry has been blown up, and all his savings tied up in a Spanish bank. Fleeing the country in despair, he has arrived in England with nothing but what he stands up in, and with heart-rending tales of blood and thunder he extracts a friendly "loan" from sympathetic listeners. The number of Spanish foundries employing foreign managers seems to have been much greater than anyone would have credited.

MARKSMAN.

Catalogue Received

Heat-Treatment of Iron Castings. Because we wrote a leading article on the subject of the heat-treatment of iron castings, and suggested that there was room for firms to specialise in doing this class of work for the trade, Bradley & Foster, Limited, of Darlaston, Staffs, have sent us a four-page leaflet which describes the equipment they have installed and the type of work they undertake. We feel sure that this will be of as much interest to our readers as it was to us.

Fundamental Considerations in Non-Ferrous Sand Control*

By G. K. EGGLESTON

The object of this Paper is to present an introduction to sand control for those who are not familiar with the principles upon which this work has been based. The information used has been obtained from American Foundrymen's Association Papers previously published and the writer's personal experiences.

Geological History of Sands

It is generally believed that the basic rock or material of the earth was granite, and the surface of the earth to-day is some modified form of this rock. The principal minerals in granite are quartz, feldspar and mica. The quartz, more commonly known as silica, is by far the hardest of these minerals, and when subjected to abrasion or impact, is not easily broken or splintered, whereas the feldspar and mica, which are aluminium silicates containing some potassium, sodium, magnesium or calcium, are rather soft and easily reduced to a very fine state. As this granite was slowly eroded away by the elements,

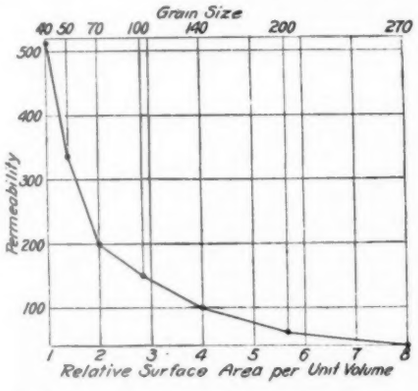

FIG. 1.—RELATIONSHIP BETWEEN RELATIVE SURFACE AREA, PERMEABILITY AND GRAIN SIZE.

principally rivers, the feldspar and mica were readily ground to very fine particles by the harder grains of quartz and fragments of granite that were carried by the water.

When such a river reached a lake, the velocity of the water gradually decreased, causing the larger particles (which would be mostly quartz grains) to settle out. This would continue on a graduated scale until the last to settle out would be the very fine silt which would be farthest from the mouth of the river. When this lake finally dried up, the centre would, most likely, contain a deposit of clay, and as one proceeded towards what was the river mouth, the percentage of clay would decrease, more quartz grains would appear, and at some spot a desirable combination of quartz grains and clay to make a moulding sand might be found. There would be more deposits of moulding sand available if it were not for the fact that the finely ground feldspar and mica must be subjected to just exactly the right conditions, or the chemical processes necessary to transform them into clay will not take place

GRAIN DISTRIBUTION

The great number and types of moulding sands on the market seem quite confusing at times, but the reasons for this are obvious. Among the principal reasons the following may be cited: The original source of the granite; the distance it was carried; the speed of the river; the size and shape of the lake in which it was deposited. All of these factors tend to vary the properties of the resultant sand. Broadly speaking, the natural moulding sands can be considered to be made up of quartz grains, clay and moisture.

The grains of the moulding sand control two important properties: (1) Permeability, which is the ability of the sand to allow air or gases to pass through it. The figures used to designate permeability indicate the quantity of air passing through a given sample under a standard set of conditions according to a standard test established* by the A.F.A. Committee. (2) The finish of the castings is also greatly affected by grain distribution.

Sieve Test

The average non-ferrous sand will consist of a mixture of grains varying from 40 mesh down to those passing through a 270 mesh sieve. Before proceeding further, it is necessary to explain the system of designating the different sizes of grains. The American Foundrymen's Association uses* the United States Bureau of Standards sieves of 6, 12, 20, 30, 40, 50, 100, 140, 200 and 270 mesh. Starting with the 270 mesh sieve which has an opening of 0.0021 in., each succeeding screen is the square root of 2 or 1.41 times larger than the preceding one, which doubles the size of the openings of every second sieve. The mesh number of a sieve merely refers to the number of wires or openings per inch of screen and does not necessarily have any definite connection with the size of the openings unless some standard system is referred to, such as the Bureau of Standards or Tyler.

If a sand is separated into its various grain sizes, it will be found that equal weights of each size will have equal volumes. This is, of course, assuming that the different sizes are of the same general shape and material. This being true, the percentage of voids will also be the same for all sizes, which is about 39 per cent. for round grains and 48 per cent. for angular ones. As the percentage of voids, or the volume of air passages, is the same for all sizes, one might deduce that the permeability for all sizes might be the same. Unfortunately, this is not true, as can be seen from some test results listed in Table I.

TABLE I.—*Relative Permeability of Sands of Varying Sizes.*

Mesh.	Permeability.	Per cent. Voids.	Shape of grains.
40	550	39.2	Round
50	341	44.2	Sub-Angular
70	205	46.1	Angular
100	86	47.3	,,
140	54	48.4	,,
200	36	48.4	,,
270	26	47.8	,,
Through 270	7	47.8	,,

Grain Size and Permeability

To study more closely the relationship existing between grains of different sizes, a series of lead shot was obtained having their diameters in the same ratio as the A.F.A. screens from 270 mesh to 40 mesh. A special permeability machine of the orifice type was constructed and calibrated to read in figures comparable to those of sand grains of the size the lead shot represented. The permeability of these shot is shown in Fig. 2. An analysis of the relationship between these grains of different sizes reveals that the surface area of a given weight or volume of grains varies inversely as the diameter, which means if two sizes are taken, such as the 270 mesh and 140 mesh, the 270 mesh being half the diameter of the 140 mesh, will have twice the surface area. Also, the number of grains in a given volume varies inversely as the cube of the diameter; in other words, there would be eight times as many 270 mesh grains as 140 mesh in a given volume. A study of the flow of air in pipes and orifices does not leave much doubt that the reduction in permeability of the different sized grains is due to the variation in the surface area. The relationship between surface area, grain size and permeability is shown in Fig. 1.

So far only conditions where the percentage of voids is the same have been discussed. However, if the percentage of voids is reduced, it has the same effect as reducing the size of a pipe through which air is flowing, and when this is done the flow is very obviously reduced. A rather small drop in voids causes a relatively large drop in permeability. Fig. 2 shows the results obtained by combining different grain sizes to hold the surface area constant while the percentage of voids has been varied.

Combination of Grain Sizes and Permeability

As stated previously, a sand usually consists of a combination of grain sizes. It will be impossible to illustrate all the combinations which might occur, but an attempt will be made to show some of the combinations which seem to be most important. If some 40 mesh grains with

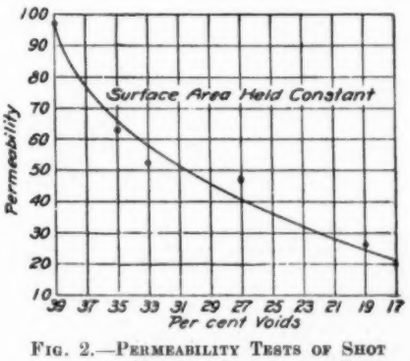

FIG. 2.—PERMEABILITY TESTS OF SHOT WITH DIAMETERS IN THE SAME RATIO AS A.F.A. SCREENS FROM 40 TO 270 MESH.

a permeability of 500 have 270 mesh grains with a permeability of 40 added to them, up to about 30 per cent. of the 270 can be added without increasing the volume of the sample, as the smaller grains merely fill in the void spaces between the 40 mesh grains. Fig. 3 shows the effect on the permeability of combinations of 40 and 270 mesh grains. The very rapid drop in permeability with only a small percentage of 270 grains illustrates very clearly how a small amount of a fine material can greatly reduce the permeability of a normally open sand. It is interesting to note that a considerable part of the permeability curve lies below that of the 270 mesh grains.

It was a condition similar to this, encountered in the foundry with which the author is associated, which prompted making these tests. Two sands each with a permeability of about 20 were mixed together to give a permeability of 10. Upon investigation it was found that one sand contained mostly 100 mesh grains with enough fines to reduce the permeability to a low figure and the other was much finer, mostly 270 mesh, but when combined, the 270 mesh grains just filled up the voids of the 100 mesh grains, thereby lowering the permeability.

Fig. 3 shows the effect of adding 70, 140 and 270 mesh grain to the 40 mesh. As the difference in the diameter of the two grain sizes is reduced, the decrease in permeability is much less drastic for small additions of the smaller grains.

* Paper presented to this year's annual meeting of the American Foundrymen's Association. The author is metallurgist, Detroit Lubricator Company, and chairman, A.F.A. Non-Ferrous Division Committee on Sand Control.

* "Standard and Tentative Methods of Testing and Grading Foundry Sands," A.F.A., March, 1931, pp. 34-45.

It was thought desirable to have as fine a sand as possible for the sake of casting finish, and one way of doing this and still keeping the permeability sufficiently high is to have as many grains as possible nearly the same size. Specifications from the author's foundry call for 75 per cent. of the grains to be on three adjacent sieves.

Grain distribution has a very marked effect upon the casting surface, and the larger the grains are the rougher will be the surface. The closer a sand comes to containing grains all of one size, the more uniform the finish will be. It does not take many large grains mixed into a fine sand to spoil an otherwise good finish, and if finish is an important consideration, the removal of coarse particles of sand or metal should be given considerable thought.

CLAY CONTENTS

Among the more important properties of a moulding sand that depend upon the clay content are green strength, dry strength and durability. Green strength is the strength of the sand in the green condition. It must be high enough to prevent the mould from deforming after being made. Dry strength is the strength of the sand after the moisture has been removed by baking at about 104 deg. C. This is important because the metal, upon flowing into the mould, dries the sand and if the strength is not high enough in this dried condition, there is the possibility of washing sand into the casting. Durability might be defined as the useful life of the sand and is governed by the rapidity with which the clay deteriorates or burns out.

Properties of Clay

There are six or more different types of clay, each having* separate and distinct properties, such as strength, either green or dry; fluidity, or the property to flow under pressure without breaking; rehydration, the ability to pick up moisture after being dried out; transformation temperature, the temperature at which the clay undergoes a permanent change in composition, thereby losing its value as clay; fusion temperature or the temperature at which the clay substance melts or fuses.

Some clays have about three times the strength of others, provided the clay particles are the same size in each case. The particle size must be taken into consideration as the strength and fluidity increase with a decrease in particle size. The ability of some clays to rehydrate is destroyed at a temperature as low as 205 deg. C., whereas others can be heated to 538 deg. C. with very little detrimental effect. This property has a great bearing on the durability of a sand as a sand containing a clay which would be destroyed at 205 deg. C. could not be expected to last very long, whereas a 538 deg. C. clay should give very good life.

Most sands contain two or more types of clay, so that the resultant properties will be a combination of the properties of each. For example, two sands were taken having the same total clay content. Each was heated to 315 deg. C. for two hours, then moistened and tested, heated to 650 deg. C. for two hours and again tested. One sample lost 45 per cent. of its strength after the first treatment and 70 per cent. after the second treatment, while the other lost only 10 per cent. at 315 deg. C. and 48.2 per cent. at 650 deg. C. The clay of the first sand may have contained about 50 per cent. of a clay with a decomposition temperature below 315 deg. C., the other half being a high temperature clay. A sand such as this would be expected to show a rapid drop in strength when first put into use, then decrease very slowly. The other sand should show a gradual decrease in strength from the beginning. It is obvious that the total clay content is no true indication of the strength or durability of a sand. Unfortunately, the determination of clay types at the present time is not practicable because of the expense, but some type of durability test similar to that just described is useful.

The moisture content of a sand depends on the amount required to develop the most desirable properties of the clay. Between 5 per cent. and 7 per cent. is about the range used in non-ferrous sands.

Benefits of Sand Control

What benefit might one expect from sand control? First, more uniform and better finish on the castings; second, reduction of scrap due to defects caused by faulty sand, such as washes or blow-holes; third, in some cases the replacement of two or three different sands by one single sand; fourth, the reclamation of used sand which might reduce the new sand requirements by half; and fifth, the use of cheaper local sands.

Beginning Sand Control

Where and how should a foundryman start sand control? This might be accomplished in numerous ways with equally good results. The following are the writer's own ideas on the subject, discussed along with the procedure and results of some of the work at the plant of the Detroit Lubricator Company.

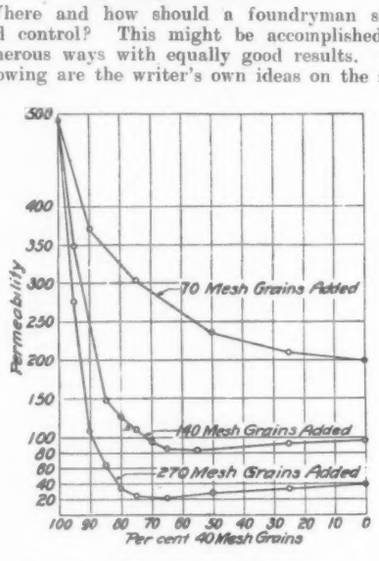

FIG. 3.—EFFECTS ON PERMEABILITY OF ADDING 70, 140 AND 270 MESH GRAIN TO 40-MESH SAND.

Uniformity is the most important consideration in sand control; in fact, in any foundry operation. It would be better to have a foundry operation uniformly poor than have it good one day and bad the next, because as long as it is uniform one can, in most cases, allow for it, but when it is constantly changing the chances of correcting it are very slight. One foundryman had trouble with blows on Monday and Tuesday; Wednesday and Thursday everything was satisfactory, while on Friday and Saturday the moulds dropped and washed. Investigation showed that new sand was being added on Monday morning only. This put too much new sand in the heaps for the first two days' work, and by the end of the week the sand became too weak. When he added smaller quantities of new sand each morning, he had good sand all the week. This point of small uniform additions of new sand cannot be too strongly emphasised, as it does more to keep the sand uniform than anything else.

Equipment for Control

While some testing equipment is desirable, considerable good can be accomplished by just being careful to make small additions to the heaps at regular intervals. The writer believes additions should be made not less often than once a day or preferably two or three times per day. The author finds that adding the new sand at the knock-out is quite satisfactory, as it seems to mix into the remainder quite rapidly this way.

It is possible that some foundrymen have been frightened by the elaborate and expensive equipment offered for sale. While this equipment is desirable to have, it is not necessary to start a sand control programme. Excellent results may be obtained from the following inexpensive equipment: A permeability machine; some simple type of strength machine which can be purchased from one of several manufacturers; a means for drying samples for moisture content, for which a small gas oven placed on a gas plate, or the core oven, may be used; scales of about 300 grms. capacity and some jars in which to keep the samples. These should be all the equipment necessary to start a system of sand control.

Starting Point of Control

As a starting point, it is recommended that regular tests of the present method of handling the sand be made, and one or more tests should be made every day, if time permits. This will give the variations from one batch to another and any changes from day to day, thus establishing an important basis from which to continue experiments. The time and amount of new sand additions should be noted and if any difficulty is experienced with a certain casting, it should be recorded along with the batch of sand it was made from and the approximate time of new sand additions. After about a month, sufficient information should have been obtained, if properly correlated, to start a programme for improving the sand conditions. From these tests, the variations obtained can be determined and also what conditions are producing the best casting. This is the condition that should be maintained at all times.

If a month or so of preliminary testing has shown that there is more than a reasonable amount of variation in the properties of the sand, efforts should be made to reduce these variations by making the sand additions at definite times and amounts.

Adding New Sand

If a sand mixer is not available, mixing the new sand in at the knock-out is a good method. If sand mixing equipment is available, mixing about half floor sand and half new sand together and then making the additions to the heap works out very nicely. The question of how much new sand can be added without causing trouble has been asked numerous times. The answer is that it all depends upon the sand. Some sands can be used alone with satisfactory results, while with others additions of 10 or 15 per cent. might be the limit. This difference, at least to some extent, is due to the presence of organic material, such as any form of plant life, which will evolve a considerable volume of gas when first heated up but will not be affected on continued heatings.

If the sand does not give the required results, even when kept at its best condition, a more satisfactory sand must be obtained. For example, if the sand is satisfactory, except that the casting surfaces are too rough, a sand with a smaller amount of coarse grains but with the same permeability and strength may be the solution. In fact, the sand producer will in most cases be able to make some very satisfactory recommendations. It is quite possible to have one sand suitable for all the work in the foundry. That is, of course, assuming the same general type of metal is used throughout. The foundry with which the author is connected makes castings weighing from less than an ounce up to 200 lbs. without any difficulty, using the same sand. It is merely necessary to select a sand sufficiently strong and open for the largest casting and yet fine enough to produce a satisfactory surface. There are many sands on the market which will meet this requirement.

(*Concluded on page* 142.)

* Grim, R. E., Bray, R. H., and Bradley, W. F., "The Constitution of Bond Clays and Its Influences on Bonding Properties," Trans. A.F.A., Vol. 44 (1936), pp. 211-223.

Function of Tuyeres in Cupola Operation*

THE CASE FOR A SINGLE ROW

By H. V. CRAWFORD

Tuyeres are essential in order to melt in the cupola, but their function and construction can be completely covered in one paragraph. They are openings in the shell of the cupola through which the air from the blower passes into the bed. Their function is simple, as they play no other part in the operation than to permit the air to flow through the lining into the bottom of the bed. Their construction should be such that the air will be evenly distributed all around the bed and thus assist even burning of the bed. This means that tuyeres should be continuous on the inside and should be in one row at a point as low as possible in the bed, still leaving sufficient room below for the accumulation of the iron in the well.

The path through which the air must travel through the tuyeres is so short that they have little effect on the amount of air flowing as long as they are from three to six inches high. Any increase beyond six inches will not result in better operation, but will mean that there must be more coke in the bed, so that the air entering at the upper part of the tuyeres will not be too close to the iron charges. The tuyeres should be considered, more or less, as detail of construction and not as one affecting the operation by mysteriously controlling the air going into the bed. Controlling the air supply is the function of the blower. This should be so regulated that the volume and pressure of the blast will vary in order to keep constant the amount of oxygen consumed. Oxygen and carbon combine according to weight, so that, for the best and most consistent results, it is necessary to keep their weights constant at all times. Proper regulation of the blowing equipment will automatically keep the oxygen constant, irrespective of the size or kind of tuyeres used, as long as they are not allowed to become blocked with slag and iron.

Recent Developments

There has been considerable discussion lately over the use of tuyeres, and in a number of cases extensive changes have been made in the cupola construction to give regulation of the air by means of valves in the tuyeres. Not only are there screw valves in the main tuyeres, but as many as three additional rows of upper tuyeres are used, each tuyere having its own control valve. In this way an attempt is made to proportion the blast between the main and upper tuyeres. Cupolas with upper tuyeres in several rows, with a damper in each tuyere to adjust the air flowing through each tuyere, were used many years ago. Apparently the new cupola of this type is different from the old, in that the adjustable screw valves used are of better construction, with the idea that the air supplied through these tuyeres can be adjusted within very close limits. The method of operation is different, in that the main tuyere valves are adjusted throughout the heat, while the upper tuyere valves are not changed.

No doubt, improved methods of cupola operation are used, and much closer attention to the cupola is given, so that improved results must necessarily follow. However, most of the improved results must certainly come from the hand control of the amount of air flowing into the cupola, and any effort along this line is a step in the right direction. It would seem that adjusting a set of valves in the tuyeres is only a temporary arrangement, and the results accomplished will not compare so favourably with those obtained, with other operating conditions the same, when the total amount of oxygen delivered is not only kept constant, but at a minimum.

Problems of Deep Fuel Bed

It is claimed, however, that these improved results are obtained from putting part of the air through the upper tuyeres and burning the CO gas formed in the bed to CO_2 and thereby obtaining perfect combustion. This is the same claim made years ago for the first cupola with auxiliary tuyeres, and no recognition is given to the fact that the CO_2 made by this auxiliary air combining with additional carbon coming from the bed will again form CO. In any case, an effort is made to operate the cupola like a boiler furnace where the oxygen in the primary air, which corresponds to the air going in at the lower tuyeres of the cupola, enters under the coal and combines with the carbon to form gases which, in turn, combine with the oxygen in the secondary air coming in above the coal, which corresponds to the upper tuyeres in the cupola, to give more nearly perfect combustion. The problem, however, is entirely different, as in the boiler furnace there is only one layer of fuel, and any excess oxygen in the secondary air and the CO_2 gas formed do not have an opportunity to combine with more carbon to form CO gas.

Tests on a cupola provided with special tuyeres and lined to 54 in. showed that the iron-to-coke ratio (less bed) could be increased from 10 to 1 to about 15 to 1 with an increase in the melting rate from 10.5 to 13.03 tons per hr. This is equivalent to an 8.8 per cent. increase above the maximum rating of a 54-in. cupola, which is 12 tons. The CO gas at the charging door was also reduced, and there was an increase in temperature. No information was given in regard to the kind of coke used, the kind of iron, the length of the heat, height of bed, or the amount of air used, all of which are important. The maximum temperature was given as only 1,349 deg. C. In another case the amount of coke used was reduced, the melting rate increased 10 per cent., and the temperature increased from 1,320 to 1,352 deg. C. Iron at this temperature, as well as that above, would be too cold to pour in most foundries.

Oxygen Control

The union of the oxygen of the air and the carbon of the coke follows certain well-known laws, and there does not seem to be any practical or theoretical reason why the splitting up of a certain amount of air going into a part of the coke in the bed or above the bed, in using various size, design, number and location of the tuyeres, will give any better results than when using one row of tuyeres. Knowing accurately the amount of oxygen going into the cupola and keeping it constant is the important thing. This can be accomplished simply, by the automatic opening and closing of a valve in the air supply line rather than by the laborious hand manipulation of a number of valves in the tuyeres, which, at the most, is only guessing. The claims for the special tuyeres are so broad that it seems necessary to study the subject in detail to show that special tuyeres, arranged in two or more rows, are not of any advantage over ordinary tuyeres in one row, and that the latter under proper operating procedure, will produce the best and most consistent results.

Combustion in the Cupola

The operation of the cupola is largely a process of combustion. Four well-known laws pertaining to combustion are given below:—

(*a*) $C + O_2 = CO_2 +$ heat; or, on a weight basis, 1.0 lb. C + 2.667 lbs. O = 3.667 lbs. CO_2 + 14,550 B.Th.U.

(*b*) $2C + O_2 = 2CO +$ heat; or, on a weight basis, 1.0 lb. C + 1.333 lbs. O = 2.333 lbs. CO + 4,350 B.Th.U.

(*c*) $C + CO_2 = 2CO -$ heat; or, on a weight basis, 1.0 lb. C + 3.667 lbs. CO_2 = 4.667 lbs. CO − 5,850 B.Th.U.

(*d*) $2CO + O_2 = 2CO_2 +$ heat; or, on a weight basis, 2.333 lbs. CO + 1.333 lbs. O = 3.667 lbs. CO_2 + 10,200 B.Th.U. (Note: 2,333 lbs. CO contains 1.0 lb. C.)

In a certain case, with only one row of ordinary tuyeres, the operation was on the basis of a 10 to 1 ratio with 42 lbs. of carbon burned per minute, using 84 lbs. of oxygen per minute.

84 ÷ 2.667 gives 31.5 for the lb. of C to CO_2 by reaction (*a*)

84 lbs. O_2 + 31.5 lbs. C = 115.5 lbs. CO_2 + (31.5 × 14,550) B.Th.U. (1)

And the remaining 10.5 lbs. C combines with CO_2 according to reaction (*c*).

38.5 lbs. CO_2 + 10.5 lbs. C = 49 lbs. CO − (10.5 × 5,850) B.Th.U. (2)

The heat evolved less the heat absorbed in the above equations, or 458,325 − 61,425 leaves 396,900 B.Th.U. available. The amount required for melting and superheating the iron to 1,537 deg. C. was 272,261 B.Th.U. per min., so that 396,900/272,261 gives almost 50 per cent. more heat than required by the iron. The heat absorbed in CO formation is accounted for in equation (2), so that 396,900 − 272,261, or 124,639 B.Th.U., were available to take care of the losses in slag, radiation and sensible heat out of the top, or almost half as much as used to melt and superheat the iron. The 49 lbs. of CO in equation (2) were not enough to make the gases rich enough to burn, except for a small percentage of the time, so that little flame was present at the charging door.

Using upper tuyeres and splitting up the air so that 56 of the 84 lbs. of O_2 in equation (1) will go into the main tuyeres and 28 lbs. through the upper tuyeres, the carbon burned to CO_2 would be 56 ÷ 2.667, or 21 lbs., and, according to reaction (*d*),

21 lbs. C + 56 lbs. O_2 = 77 lbs. CO_2 + (21 × 14,550) B.Th.U. (3)

The total carbon charge is 42 lbs. per min., so this leaves 21 lbs. of carbon, which must certainly burn to CO according to reaction (*c*), as follows:—

21 lbs. C + 77 lbs. CO_2 = 98 lbs. CO − (21 × 5,850) B.Th.U. (4)

The heat in the bed would then be 305,550 − 122,850, or 182,700 B.Th.U. However, only 56 of the 84 lbs. of oxygen have been used, and the difference, or 28 lbs. of oxygen, can be added through auxiliary tuyeres to burn CO to CO_2, so that, according to reaction (*d*),

28 lbs. O + 49 lbs. CO = 77 lbs. CO_2 + (21 × 10,200) B.Th.U. (5)

The total heat available is then 182,700 + 214,200 or 396,900, the same as above with only one row of tuyeres so that, as far as the total heat available is concerned, there is no difference. However, with one row of tuyeres all the heat, or 458,325 B.Th.U., is available in the bed. This not only gives a higher temperature in the zone of highest temperature, but all of the drops of iron pass through this zone and the extremely hot gases are in contact with the iron longer. With the other method only 305,550 B.Th.U., or only about 65 per cent. as much heat, is available in the bed. Actually, in this case 122,850 B.Th.U. are absorbed in the bed according to equation (4) and the heat available in the bed under the iron is only 182,700 B.Th.U. as compared to 396,600 with one row of tuyeres. The

* This article from "The Iron Age" has been slightly abridged. The author is in the industrial department of the (American) General Electric Company.

214,200 B.Th.U. added by equation (5) is distributed in several rows above the bed and there will be a lower temperature in the zone where the highest temperature should prevail. More heat is evolved nearer the charging door, and the hottest gases are not in contact as long with the iron charges. Actually more heat (214,200 B.Th.U.) is available above the bed than in the bed (182,700 B.Th.U.). The cupola is therefore operated upside down, as the iron should start to melt as it comes into a zone of about 1,204 deg. C., or the melting temperature of the iron, and then drop down through zones of gradually increasing temperature and at last pass through the zone of maximum temperature. The iron cannot be any hotter than the hottest zone in the cupola, and this zone certainly should not be above the point where the last iron melts. If the auxiliary tuyeres are low enough, or the bed is high enough, all of the air will be added in the bed. Some will combine with C to form CO_2, and some will combine with CO to form CO_2, but in any case the heat available will be the same as if all the air had been added through one row of tuyeres. The disadvantage is that the bed must be higher or oxygen from the upper tuyeres will be too near the melting iron, and excessive oxidation of the iron will take place. If the upper rows of tuyeres are above the bed, then part of the time air will be blowing directly on the melting iron charges as they pass by these points. The greater the percentage of air added through the auxiliary tuyeres, the worse the above conditions.

In equation (4) 98 lbs. of CO are formed, and only 49 lbs. of this are used in equation (5) Therefore, in order to use up all of this, it is necessary to use 56 instead of 28 lbs. in (5) and the total O_2 will be 56 lbs. in (3) and 56 lbs. in (5), or a total of 112 and (5) becomes—

56 lbs. O_2 + 98 lbs. CO = 154 lbs. CO_2 + (42 x 10,200) B.Th.U. (6)

and the total heat available will be 182,700 from (3) and (4) in the bed, and 428,400 from (6) above the bed, or 611,100 B.Th.U. The results, therefore, are the same as if all the air was added through one row of tuyeres in accordance with reaction (*a*)

112 lbs. O_2 + 42 lbs. C. = 154 lbs. CO_2 + (42 × 14,550) B.Th.U. (7)

which gives the same as above, or 611,110 B.Th.U. If then, with either one row or two or more rows of tuyeres there is used the same amount of oxygen, the heat evolved, 611,100 B.Th.U., and CO_2 formed, 154 lbs., are the same, with the disadvantage of upper tuyeres as previously stated. This is also perfect combustion which, due to the nature of the operation, is not possible in the cupola, as some of the CO_2 must react with C to form CO, so that with 112 lbs. of O_2 burning 42 lbs. of C to CO_2, the CO_2 will pick up more carbon, and more than 42 lbs. of C will be used, and the ratio will drop below 10 to 1. By no manner of reasoning can it be argued that the CO formed with several rows of tuyeres will be less than that with only one row of tuyeres when the total CO_2 formed is the same in both cases.

Formation of CO

In several articles, on the use of auxiliary tuyeres, reference has been made to the deliberate promotion of CO formation according to reaction (*b*), and then burning this to CO_2 by introducing additional oxygen through the upper tuyeres. This means that CO_2 is formed by reactions (*b*) and (*d*), and for each pound of C burned, the B.Th.U. available will be just the same as for reaction (*a*), and, of course, exactly the same amount of oxygen will be required. There is no reason why any CO formed according to this reaction in the lower part of the bed should not immediately combine with oxygen present from the incoming air to form CO_2 instead of waiting until it reaches the upper tuyeres.

To show that it does not make any difference which way the CO_2 is formed, figures can be made on the basis of only half of the carbon in equation (1) burning to CO_2 in this manner or:

42 lbs. O_2 + 15.75 lbs. C = 57.75 lbs. CO_2 + (15.75 × 14,550) B.Th.U. (8)

then the remainder will burn to CO in accordance with (*b*) or:

21 lbs. O_2 + 15.75 lbs. C = 36.75 lbs. CO + (15.75 × 4,350) B.Th.U. (9)

The total oxygen used is then 42 + 21 or 63 lbs., leaving a balance of 84 – 63, or 21 lbs. to burn CO to CO_2 by (*d*). This is just enough to burn the 36.75 lbs. of CO formed in (9), or:

21 lbs. O_2 + 36.75 lbs. CO = 57.75 lbs. CO_2 + (15.75 × 10,200) B.Th.U. (10)

Therefore, the total CO_2 is 115.5 lbs., and the B.Th.U. is 229,162.5 + 68,512.5 + 160,650, or 456,325, or the same amount as given in (1).

If dividing the air through several rows of tuyeres and using valves in the tuyeres to balance the air or proportion it between the tuyeres is not the reason for improved results, it then must follow that it must be due to the manipulation of the valves keeping the air flow more constant and at a minimum. The accuracy and the labour involved then is to be compared with using the proper equipment automatically to keep the oxygen weight constant irrespective of the many things that will cause it to vary over a very wide range. This includes changes in atmospheric temperature and barometric pressure, which may mean as much as a one-third variation in the volume of air, the iron and slag formation over the tuyeres, the size of the coke, the number of charges of iron in the cupola, the size of the pieces of iron scrap in the charges, the height of the stack, or the velocity or direction of the wind over the stack.

Reducing and Oxidising Atmosphere

In regard to the further claim of improvement due to the iron melting in a reducing atmosphere, it would seem that this would be off-set by the oxidation taking place, because the upper tuyeres being so near the melting iron that oxygen would be reaching the pieces of iron in an appreciable quantity. If it can be proved that oxidation will be reduced under these conditions and would give much better results, it would seem that even better results could be secured by using only one set of lower tuyeres with excessive air and excessive height of bed. The bed can certainly be high enough, so that there will be enough incandescent coke in the bed to convert all of the CO_2 to CO. The iron then will be melting in a reducing atmosphere and passing through such an atmosphere until the lower part of the bed is reached, where this CO_2 is being formed.

It is necessary to burn a certain amount of coke to CO_2 in order to secure enough heat to melt and superheat the iron and, in this burning of CO_2, a definite amount of oxygen by weight is required. Therefore, the melting iron is bound to drip through the region containing oxygen from the air and where CO_2 is being formed. With a minimum amount of air, this region is limited to as narrow a space as possible, and the oxidising of the drops of iron, as they pass through this region, will thereby be reduced to a minimum. In any case, the nature of the operation is such that it is not possible to melt iron in the cupola and not have it pass through an oxidising atmosphere, the extent of which depends on the total amount of oxygen used and not on how it may be divided between two or more rows of tuyeres.

In one particular case a cupola with an auxiliary tuyere system is operated with a 54-in. bed, which brings the bed up above the top row of auxiliary tuyeres. The actual amount of coke used on the bed was 850 lbs., and on top of this was placed the first charge of coke. The bed up to the first charge of iron was around 60 in. at the start and all of the air was, therefore, introduced below the first charge of iron. However, it is stated that only 30 or 40 per cent. of the bed coke is recovered, which would indicate that as the heat progresses, the bed continues to fall and, not only does the bed drop down to about 20 in., so that at times the auxiliary tuyeres are blowing air directly on melting iron, but the amount of coke burned out of the bed really increased the amount of coke burned in melting a given amount of iron and should be added to the coke in the charges, and the ratio reduced accordingly. In this case, the ratio was increased from 8:1 to 11.2, less the bed, or 9.6:1, including the bed, so that it might be figured that the ratio is really improved from 8:1 to something like 10:1. Also, the temperature as given was approximately 1,450 deg. C. It is very common practice to find cupolas operating at 12 to 1 with temperatures higher than this without using the auxiliary tuyere system or any other system other than definite control of the amount of air being supplied and the proper attention to the other phases of cupola operation, including, of course, the important control of the amount of carbon supplied.

Even Melting

It is further claimed that, with auxiliary tuyeres, not only more even melting prevails throughout the whole area of the cupola, but the periodical shutting off of each tuyere helps to keep the tuyeres clean. The main tuyeres are closed one at a time all during the heat. No. 1 is closed for a certain length of time, then it is opened, and No. 2 is closed, and so on, around the cupola during the entire heat. How this gives better melting results is not explained, but it is true that it may help to keep the tuyeres clean. As long as there is enough wind-box pressure to force the right amount of air through the tuyeres into the bed, there is no particular advantage in keeping the tuyeres absolutely clean. The fact that while one valve is closed, the tuyere becomes clean indicates that the tuyeres do become partially closed, even with this system. After a valve is opened and the tuyere is cleaned, the amount of air flowing will then gradually decrease as this tuyere again closes up until such a time as this same valve is closed again. This indicates that the amount of air flowing through the different valves and tuyeres is not under definite control, and no means of knowing at any time how much air is flowing through each one is provided.

Closing one valve will reduce the total amount of air flowing into the bed, and increase the amount flowing through the other valves and tuyeres that are open. The amount and the variation will depend on how much the tuyeres are plugged up and the type of blower used. While the opening and closing of the valves will vary the amount of air flowing into the bottom part of the bed as well as the upper part, there cannot be much advantage in varying the amount supplied to the various parts, even if it were possible to know how the amount was divided. Using only four tuyeres and closing one of these at a time limits the melting to the other three. Therefore, the amount of coke burned on the side of the cupola where the tuyere is closed is reduced and the bed on this side would tend to build up. This might not cause so much unevenness of the bed if it were positively known how much air would be supplied by each tuyere and each tuyere closed the same length of time. It therefore seems best that all of the air should be supplied at the bottom of the bed and in a continuous manner all around the cupola to keep the bed even.

Softness of the Blast

The "softness of the blast" is a very questionable phrase, but, in any case, it is dependent upon the amount of air actually passing into the bed and not how it gets there, which

(*Concluded on page* 142.)

A New Method of Making Pattern Plates*

By G. DELCROISETTE

The services rendered to the foundry by the use of moulding machines have their limitations. The cost of pattern plates is most often the chief factor; it confines the use of machines to big runs, the number varying according to the shape of the casting, its intricacy and its size. The foundries which are favourably placed from this point of view are those attached to quantity-production mechanical-construction works (particularly in automobile manufacture), those which are clearly specialised for the production of articles for which there are very large markets, and finally foundries which, by reason of the size of their plants and their *clientèle*, are able to undertake quantity production and to reject or sub-let orders which are not of a suitable nature for them to manufacture.

The small or medium-sized jobbing foundry often finds it impossible to install moulding machines; or, if it does possess them—and it is often a wise policy on the part of the management in order to be able at one time or another to undertake quantity-production work which is offered to them—it is difficult to keep them sufficiently utilised to reap the maximum profit from them and then write them off rapidly. Therefore, every means offering a reduction of pattern-plate costs is of outstanding interest.

A method of this type was described recently at a meeting of German foundrymen, and deserves attention.† It must primarily be pointed out that the following article does not reproduce exactly the description referred to; certain modifications have been made which will be detailed later when explaining the reasons why they were added.

This method is not claimed to be universal, nor to supplant other methods of pattern-plate making, but only to add in certain measure to the scope of moulding-machine usage. It is not applicable to every casting, but only to those the pattern of which can be cut by a flat joint, and providing also that the two half-patterns have the same contour. For example, it could not be applied to a pattern carrying a round and a square part, the joint of which would be at the separation line of these two parts. In spite of these limitations the method is interesting because it necessitates only the cost of the apparatus as the initial outlay, and after that the pattern plates can be made by the moulder himself, on the spot, in a few minutes.

The success of the method depends on the precision of the apparatus, which should be meticulously finished and definitely practical, but when this precision has been assured, the success depends only on one thing—that the moulder should know how to make the position of a ruler coincide with that of a line, which is not very difficult.

The apparatus calls for an iron plate A (Fig. 1) which is provided with locating box pins B, and two grooves C made in the thickness of the long sides. The iron plate also carries two pins (not shown in the diagram) which serve to attach it to the moulding machine in the usual way. Starting from the two symmetrical axes 0, the plate is divided in both directions into equal parts numbered 1, 2, 3, etc., and at these divisions are marked transverse and longitudinal lines forming a series of squares. The device carries also a transverse ruler D, provided at top and bottom with heels or slides E and E', which can be slid without play in the grooves C. Half way up this ruler is made a machined groove F. Finally, a longitudinal ruler G, fitted with a slide H which can be slid without play in the groove F, is also provided with a hole I, in which can be placed a bolt or pin with a wing-nut serving to fix ruler G on transverse ruler D. When they are thus assembled these two rulers should form a right angle; in other words, they make a tee; their faces should be quite plane and perpendicular to plate A. This perpendicularity is assured on the one hand by the slides E in the grooves C, and on the other by the slide H in groove F.

Suppose that one has to mould castings occupying less than half the box, so that one is able to make in each mould two castings disposed symmetrically about the longitudinal or the transverse axis. One of the half-patterns is placed on table A, almost in the position which is judged to be most suitable to arrange the necessary distances between the two moulds and between these and the box. One then slides ruler D up to the nearest transverse division, for example, 5; it is to be noted that this ruler is always placed so that its working face (on the side of ruler G) coincides with one of the line of the squares; this point demands most attention from the moulder. He should adopt a constant way of doing it, by always bringing ruler D *exactly against* a transverse line, or making it *exactly cover* this line. The best method is to cover the line and to instruct all moulders who will have to make use of the apparatus to observe this fixed principle. It must not be lost from sight that an error in ruling will be doubled at the time of moulding and will therefore result in castings which are more or less varied.

One next brings the ruler G against the half-pattern and fixes it in that position. Contrary to ruler D, this can be brought into place without taking into account the longitudinal lines of the squares.

Working Details

The tee DG being set, one covers the joint-face of the half-pattern with a thin coat of special quick-drying glue and places it in the angle of the tee, touching both rulers. The glue sets in a few seconds.

Without loosening the wing nut fixing G on D, one raises the tee and turns it over about the transverse or longitudinal axis, according to the particular case being dealt with, and one brings ruler D to coincide with the transverse line having the same number as previously (which in this example was 5), either the same line if the moulds should be symmetrically disposed in relation to the longitudinal axis, or to the other side of the transverse axis if it is in relation to this that the moulds should be so placed. In the first case, ruler G will automatically take up the position symmetrical to its first position in relation to the longitudinal axis; in the second case, it will return to its anterior position.

In the angle of the tee in its new position one glues the second half-pattern, making it touch the two arms by the same sides as for the other half-pattern.

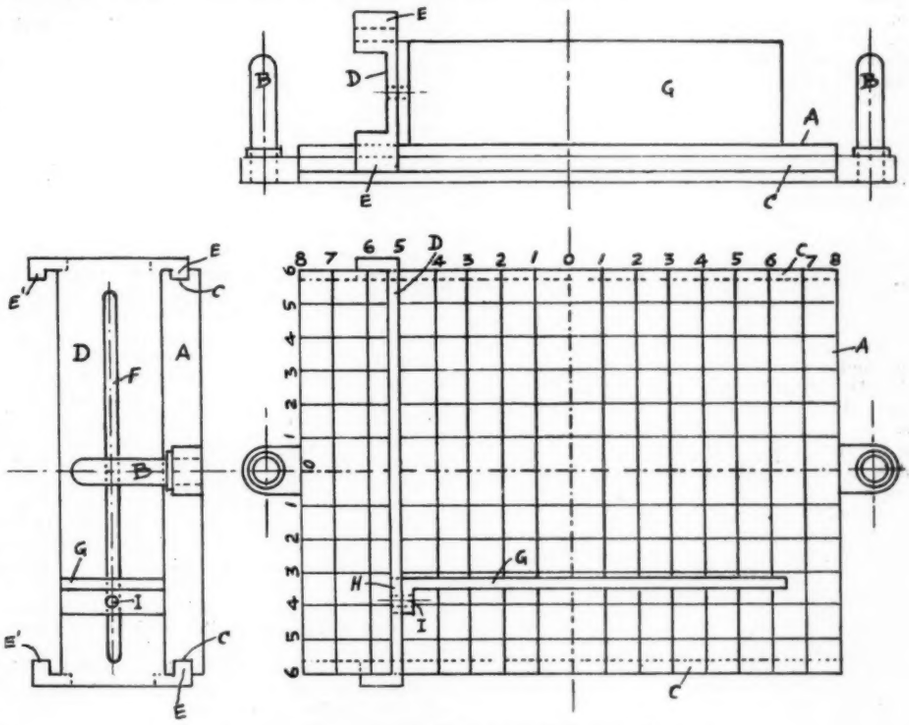

FIG. 1.—APPARATUS FOR PREPARING PATTERN PLATES.

If, instead of two castings, the box can hold four, six or eight, etc., two, three or four, etc., patterns will be made and each dealt with in the same manner as described above. Of course, one can work equally well with patterns of different castings. One proceeds on the same lines for the runners, for which wooden half-patterns will have been made.

This sequence of operations results in a reversible pattern-plate at an extremely low cost. In practice, to make it demands only a very short time, the glue setting extremely quickly. It will serve equally well for ten castings as for a thousand or more. As with all reversible patterns, it has the advantage of requiring only half the number of patterns as of castings per mould; also, it gives identical upper and lower parts, apart from the runner which is cut in a half-box part for each pair.

* Translated from "Revue de Fonderie Moderne."

† Paper by Ing. Arthur Lentz presented to the German Foundry Technicians' Association, abstracted in "Die Giesserei," April 23, 1937.

If the casting is very large, it will be necessary to provide two identical plates A mounted on two machines. By means of the tee DG a half-pattern is glued in a suitable position on one of them, then the tee is turned over 180 deg. to place it on the other plate, on which the second half-pattern is glued. The same procedure is followed for the runner and in-gate unless they are arranged in the top or the bottom part only.

When moulding is finished, the half-patterns are detached by a sharp blow of a wooden wedge against the pattern edges, directed parallel to the table. The apparatus can then be used for another mould.

Process Criticised

It was explained earlier on that the description just given is different from the original one. In the latter the ruler D carries slides only at the bottom, E, and not at E'. It is difficult to see in these circumstances how one can turn the tee over 180 deg. and be assured of its position on table A without dismounting and remounting ruler G, which calls for a delicate adjustment that is contrary to the very principle of the method.

The original description does not indicate, moreover, the presence, at the end of ruler G, of the slide H, running without play in the groove F. This detail seems to be indispensible to ensure that ruler G is perpendicular on table A, which is a necessary condition in order that its two edges will be able to mark successively the two half-patterns.

The description does not give any indication, other than what has been reproduced, as to the nature of the glue employed. Has the author of the Paper invented a special glue, the secret of which he wishes to preserve? In any case, there are on the market numerous varieties of strong rapid-drying glues which adhere well to wood and sufficiently to metal to allow very many moulds to be made and, at the same time, separation of the pattern from the plate to be made easily by a sharp lateral blow. Among these glues it is advisable to choose those which are the least susceptible to moisture, in order to avoid untimely separation of the pattern from the plate when large outputs are involved. Certain glues, termed "soude-grès," appear to answer quite well in these conditions. It is to be noted that separation will be facilitated if the plate A is made of a very close-grained metal and is well polished.

One other comment may be made. Like the author of the Paper in question, we have indicated a squaring on plate A. The transverse lines are essential because they serve to mark the two positions of ruler D. As for the longitudinal lines, they serve no useful purpose once ruler D is fitted, as shown above, with slides E'. In these circumstances the longitudinal lines can be dispensed with, with the exception of the axis.

Function of Tuyeres in Cupola Operation

(*Concluded from page* 140.)

gives the best and most consistent result. A minimum amount of air, to burn enough coke, to provide enough heat, for melting and superheating the iron supplied, consistently will give the best possible results. The use of a cupola with special tuyere arrangements will not take the place of supplying the correct amount of oxygen with the proper coke in the bed and coke in the charges to give the best possible balance between the oxygen and the carbon in the bed and, of course, maintaining this balance throughout the entire heat.

Sulphur Pick-Up

Certain improvements are claimed, but no definite figures are given that the sulphur pick-up is reduced by less coke in the charges. This is apparent, but there is a large number of cupolas operating with one row of tuyeres with proper balance between the amount of oxygen and carbon used where the coke has been reduced with a corresponding reduction in the sulphur pick-up as well as CO gas at the charging door. However, this reduction can be offset by the increase in pick-up due to the amount of coke in the bed, and in the auxiliary tuyere-type cupola the bed is considerably higher than in an ordinary cupola. This applies to carbon pick-up and silicon loss as well as sulphur.

It would seem from the above that there is nothing to be gained by using auxiliary tuyeres and that the reported improvement when the old-style cupolas have been changed over to this type is because the cupolas are given closer attention. In other words, when a new feature is developed for the cupola, the cupola receives special attention for at least the first few weeks and improvements from various viewpoints are obtained. due to the fact that it responds to extra care. Soon, however, the care it is given is not so great, and then before long the operation will be back to the old basis and the new feature forgotten. This has been the procedure many times. Of course, in some cases the advantages gained by the new features are so outstanding that the extra care required in order to maintain these advantages is continued. Then, of course, the feature may be worth what it cost although the improvement may be secured in some other manner, even at less cost. It might be said that any feature which causes more attention to be given to the air supply, and is effective in keeping this more nearly constant and at minimum, is bound to give better results. However, the more nearly perfect the air supply system, the better and more consistent the result, provided, of course, attention is given to the other details of operation, especially the height of bed and the coke charges, and the physical and chemical analysis of the coke used.

Fundamental Considerations in Non-Ferrous Sand Control

(*Concluded from page* 138.)

Sand Control at the Detroit Lubricator Company's Foundry

The sand control at the author's plant at the present time is rather simple. The first step is to check the new sand as received. This consists of a screen analysis to check the grain distribution. The strength and durability are checked as previously described.

The sand cycle in the foundry can be described briefly as follows:—The floors are swept after each knock-out. This sand is put through a 4-mesh hand riddle to remove any cores or large pieces of metal. The sand passing through is then put over a double-deck screen equipped with an exhaust system which removes the dust, but, more important, it removes a considerable amount of the fines, thereby eliminating any difficulty with the fines closing up the sand. This screen is of the vibratory type. The top screen is 12 mesh, which merely acts as a "scalper" for the rather delicate 30 mesh lower screen. The metal removed by this screening is sent to the melting department and it amounts to about 0.75 per cent. of the foundry melt. The sand passing through the 30-mesh screen is taken to the sand mixer where it is mixed with equal parts of new sand. This mixture is then added to the bunkers as sand additions are required.

The sand is tested once a week for permeability, strength and moisture. This rather infrequent testing may seem somewhat lax, but the same grade of sand from the same producer has been used for seven years and, since the present system was put into practice, the maximum variation in permeability has been from 12 to 17 and the strength from 4 to 6 lbs., measured in lbs. per sq. in. in compression.

Metal Exchange Fireworks

By "Onlooker."

It is not known who was responsible for starting the upward movement recently staged on the Metal Exchange, if indeed it were "started" at all. There is a popular belief that behind these periodic upswings in Whittington Avenue a kind of hidden hand works behind the scenes to produce upheavals, which may be good for the speculator but which are of no use to manufacturers and traders. The author is of the opinion that, from time to time, something in the nature of a ramp is staged by interests who are able to turn what may be termed the convulsive price movement to their own personal gain. On this last occasion something of this sort seems to have happened, for it is certainly unthinkable that during the August bank holiday week there was any overwhelming interest by consumers. The attempt to stampede consumers failed, but it would be wrong to suppose that users did not notice what was happening; actually a very fair tonnage was taken by manufacturers on both sides of the Atlantic, for they had held off so long that a measure of buying was inevitable.

If the rise were stagemanaged, and there was every suggestion that it was, the promoters undoubtedly gambled on the fact that things have been very quiet for months past and that the stage was set for a rally. In spelter they achieved a partial success, for, at the time of writing, at any rate, the reaction in that metal has not carried the quotation back to its starting point. In copper, however, the pendulum has made practically a full swing, for electro is down to £63 again and standard stands about £57, while daily turnovers on the Metal Exchange have shrunk to a trickle, which suggests a marked lack of interest. Copper was the spearpoint of the attack, and it is there that defeat has been suffered thanks to the courage and bold policy of a minority of American producers, who by selling freely at 14 cents, even after the price in London had climbed over 15 cents, stampeded the speculators and induced a wave of selling on this side. The whole affair has been something of a storm in a teacup, for the bull account never reached anything like large dimensions and on the way down there was no evidence of stop loss selling limits.

At one stage it was suggested that the autumn buying wave had come a month in advance of its usual time, but experienced observers shook their heads over this and expressed the opinion that the first week in August was definitely too early for this to eventuate. At the best it seems to have been an affair of outposts only, an attempt to draw the enemy's fire as it were in order to discover what strength lay behind. After the punishment they suffered early in the year consumers are extremely wary of committing themselves, but the danger is that the speculator may after some months of inaction be tempted to have another shot at metals. Production is overhauling consumption and in some directions tending to outstrip it, but there is not as yet any margin to take care of speculative demands, and because of this the writer believes that another attempt will be made to precipitate a big upward move in Whittington Avenue. After the summer lull it should not be too difficult to get things going, for general trade is excellent and the Stock Exchange is in a decidedly optimistic frame of mind. Much depends on America, but here, too, the outlook is quite hopeful.

The Federated Malay States Government has prohibited the export of scrap iron from July 1. This action follows heavy Japanese purchases of scrap iron in central and northern Malaya and an increase in scrap prices from £2 3s. to £4 14s per ton in a year. An exemption from the ban is to be made in cases where the scrap is of use within the Straits Settlements.

Malleable Iron Melting Practice—Retrospective and Prospective*

By H. H. SHEPHERD

(*Continued from page* 124.)

Influence of Manganese and Sulphur

Consideration of the use of ordinary soft grey hematite irons involves consideration of the effects of manganese. The English hematite pig-irons fall into two gradings when judged by manganese content: (1) West Coast hematites, usually containing about 0.5 per cent. manganese, and (2) East Coast hematites ranging from 0.8 to 1.8 per cent. manganese. Whilst it was thought at one time that the manganese content of whiteheart should not exceed 0.15 per cent. manganese, and pig-irons fairly low in this element were largely used, the development in knowledge of the effects of manganese has, during the past ten years, resulted in gradually increased manganese percentages with beneficial results.

The reasons given for the apparent necessity of low manganese in whiteheart malleable—namely, that relatively high percentages neutralise the graphitisation restraining effect of the sulphur present, and so give rise to the formation of temper carbon, rendering the iron more like blackheart malleable—are true in substance, and explain why some whiteheart founders still insist on low manganese contents. On the other hand, it has been proved by the British Cast Iron Research Association, and others, that low-manganese whiteheart malleable, which is relatively high in sulphur, lacks ductility, though it may be very easy to machine; this condition is further aggravated in such irons when the silicon content is low. The high sulphur prevents the complete dissociation of the hematite which forms a network throughout the metal.

Much of the inconsistency in the physical properties and many failures of whiteheart castings have been due to such low-manganese, high-sulphur metal. It also offers a partial explanation of why makers of such metal find it difficult to meet a specification which calls for a minimum elongation value of 5 per cent. on 2-in. on a 0.564-in. dia. test-bar.

Charpy and Grenet, Adamson and also Leuenberger have published the results of investigations, and some of these dealt with the effects of manganese. Leuenberger's investigations, published in 1921, showed that this constituent was not so detrimental as was at one time supposed, in fact, some benefits were obtained; for example, the tensile increased with increase in manganese, whilst, within limits which varied with the basic composition of the metal and with the annealing treatment, the elongation increased. It should, however, be noted that the manganese contents of all the metal charges used by Leuenberger were present in a ratio to the sulphur content, which ensured that the "balanced ratio" was obtained, or in other words, the manganese neutralised the sulphur.

The Balanced Ratio

This balanced ratio theoretically requires that the manganese shall be 1.72 times the sulphur content, but practical requirements and metallurgical factors have also to be considered, and these will be dealt with later, though it can be stated that, in general, for whiteheart malleable, the manganese should never be less than the sulphur. For blackheart, it is necessary for there to be more than the theoretical requirement of manganese, though the excess must be limited; otherwise, graphitisation will be retarded. The excess permissible is in the neighbourhood of 0.2 per cent.

G. F. Taylor's[16] classical research, published in 1926, showed very clearly the influence of manganese and sulphur on whiteheart malleable cast iron. Briefly, his conclusions were:—

(1) Sulphur, in the absence of manganese, is detrimental to the mechanical properties.

(2) Manganese, in the absence of sulphur, decreases ductility.

(3) Manganese and sulphur together neutralise the harmful properties of each other by the formation of manganese sulphide.

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(4) Manganese may be present to the extent of one or two times the sulphur to affect the disadvantages of the latter element without incurring the disadvantage of excess of manganese, which would raise the strength but reduce the elongation value.

(5) For an iron containing 0.6 per cent. silicon and approximately 0.2 per cent. sulphur, the elongation values were more than 5 per cent. on 2 in. when the manganese content ranged from 0.4 to 0.8 per cent. A maximum elongation of 8.5 per cent. was obtained at 0.45 per cent. manganese.

(6) The most satisfactory bend tests were obtained when the manganese contents were not more than one to two times the sulphur.

The most recent information appertaining to the above subject is in the published work of Dr. Norbury[17], of the B.C.I.R.A. Norbury's work confirmed that of Taylor, and his results demonstrated that increasing the manganese contents from 0.08 to 0.57 per cent. in metal of otherwise normal whiteheart composition resulted in increased strength and ductility. These investigations clearly show that to obtain maximum ductility with good strength, the manganese should be 1.5 to twice the sulphur. It should also be remembered that irons which have the sulphur neutralised by manganese anneal more readily and at lower temperature.

Malleable iron having a manganese-balanced sulphur, and annealed according to the practice for whiteheart metal, usually possesses a fracture more resembling blackheart malleable. This is sometimes objected to, but the objection can be overcome by reducing the manganese so that it is slightly more than or equal to the sulphur. Several Continental and English manufacturers have adopted this latter practice with beneficial results in respect of machining qualities.

To conclude this section of the Paper, the author feels that it is of interest to record that, whereas at one time French and German malleable founders, in common with English founders, were accustomed to using very low manganese pig-iron, when the advantages of using higher manganese iron were realised the two former countries imported English hematite, but investigations proved that the home-produced hematites of both countries gave equally good results when the blast-furnace practices were adjusted to secure higher manganese pig-iron.

Inherent Properties of Pig-Irons

The malleable industry is closely concerned with the problem of inherent or peculiar properties sometimes exhibited by certain brands and types of pig-irons. Most founders have at some time or other experienced trouble if they changed from one brand of iron to another, or tried to mix different brands, and found that they would not blend.

Hurren[18, 19] recorded his experience of using two different brands of iron, both of which gave satisfactory results when used alone, but when mixed, a serious reduction in the tensile strength took place. The present author[20] has also recorded similar occurrences of this type in his own practice. In one case, two irons used on their own gave good results, while mixing them resulted in reduced mechanical properties, and this was found to be due to the presence of very fine clusters of primary graphite, which were either present originally and had not been taken into solution, or were created. In other instances certain brands of hematites, even when used alone, gave trouble due to the same cause. The author expressed the opinion that the solution of these problems may be found in some difference in blast-furnace practice such as: temperature of the hearth and of the blast, blast pressure, type of ore, differences in the gangue or earthy matter associated with the ore, condition of ore as smelted, proportions of different ores in the burden, type of flux and character of slag, etc. Examined in the light of knowledge gleaned from very recent investigations and research there is much support for some of the author's expressed views.

One might ask: "Should not remelting of the irons eliminate such differences or peculiarities?" In this connection Schwartz in his well-known book[21] attributed the continued use of charcoal pig-iron by some American plants as being due to "sentiment, pure and simple." He wrote: "The impression is quite general among the older foundrymen that, apart from difference in composition, there are differences in properties as between the products of different furnaces. . . Undoubtedly, before the days of analysed pig-iron these beliefs were based on sound reason; at present they would seem to be little more than prejudice. . . In view of the radical alterations made in raw materials during the malleable process, it is difficult to see how any differences, such as the form of crystallisation of graphite in the pig-iron, could survive the chemical and physical changes incurred."

The opinions expressed by the "older foundrymen" have been proved correct repeatedly, and it is now well known that remelting and subsequent treatment in the malleable process do not eliminate all the differences in characteristics of

irons. Schwartz himself has in recent years clearly[22] proved that certain characteristics of metal structure, etc., persist even through the annealing.

It can be stated with a good degree of certainty that the replacement of charcoal irons by coke-melted pig-iron was largely brought about by competitive evolution, and that the use of more modern rapidly produced pig has brought along these "mysterious" problems and peculiarities which necessitate the metallurgist considering more than the chemical composition and ordinary physical properties of pig-irons. Modern metallurgical science has not been content to dismiss these peculiarities or persistence of character as merely "hereditary." As the result of much investigation carried out on the Continent and in England, it was found that superheating of the metal tended to overcome certain of these discrepancies, and this gave rise to a proposition which was founded a few years ago and known as the "graphite nuclei" theory.

In brief, the theory was that when iron was melted in a cupola the graphite was not completely dissolved, but some of it remained in the form of fine particles or nuclei, owing to the comparatively low temperature of melting and other conditions common to cupola practice.

Silicate-Slime Theory

More recent research work by the late O. von Keil,[23] Legat, and Norbury and Morgan,[24] of the B.C.I.R.A., has led to the graphite nuclei theory being practically abandoned. Von Keil and his associates propounded the silicate-slime theory, which is based on the fact that ferrous silicate can and does exist in various amounts, and in a very fine—almost submicroscopical—state of division. These workers claimed that it was the state of division and distribution of these particles which affected the properties of cast iron, particularly in respect of graphite size. They recorded that when cast iron was prepared entirely free from silicates, the graphite was much finer and the mechanical properties of the iron were very much better than when such silicates—existing as silicate-slime—were present. Further, it was found that ordinary cast iron always contained some silicate-slime, part of which came from the pig-iron.

Norbury and Morgan's work has expanded this theory very considerably. Their investigations do not disprove the idea of nucleus effect on crystallisation, etc., but changes it from nuclei of undissolved graphite to those of non-metallic inclusions, involving not only silicate but also oxides, sulphides, etc.

J. G. Pearce[25], director of the British Cast Iron Research Association, has stated that the "new theory, briefly, supposes that these particles (non-metallic inclusions) which would normally have a melting point higher than that of the metal, are solid and crystalline before the metal solidifies, and are consequently capable of inoculating the metal to serve as nuclei for the precipitation of graphite."

The initiation of the silicate-slime and/or non-metallic impurities theory represents one of the most important developments, and it may prove to be the most important of recent years in metallurgical science which appertains to ferrous materials. Incidentally, it is also of importance in non-ferrous metallurgy, especially when applied to the modified alloys such as those of aluminium.

These theories are still being investigated. They affect the whole metallurgy of foundry melting practice, involving such examples as the use of rusty scrap, silicon additions to the charge in the form of ferro-silicon, etc., and metallic additions to ladles of metal. The practical application of these theories is not so very abstruse if one considers them along with the amazing effect which exceedingly small additions of certain materials have on certain types of cast iron a procedure which has been so successfully commercialised in the form of high-strength cast irons known as "Meehanite." Further, from what has been written above, it should be obvious that the non-metallic inclusion or silicate-slime theory explains, at least, some of the so-called "inherent" properties of irons, and thus calls for thorough consideration by every malleable founder.

The Mixing of Irons

Reviewing the cases of peculiar behaviour of certain pig-irons which have been referred to, one may consider as an example those irons which gave good results when used alone, but when mixed were not satisfactory. It would appear that a possible explanation is that, when they were mixed in the molten state, the amount of silicate-slime was increased, due, it might be assumed, to excess ferrous oxide in one iron uniting with some of the silicon in another pig-iron. The increase in silicate-slime would mean more nuclei and the possibility of precipitation of very fine primary graphite, which otherwise would not be present. The author does not offer the above as fact, but as a thought towards giving the solution to a problem which has from time to time confounded most manufacturers of malleable castings.

The theory also tends to explain in a very feasible manner the reason why superheating of the metal tends to minimise some of these supposed hereditary peculiarities. In this case, however, the silicate-slime theory must be considered somewhat separately from the non-metallic inclusions theory. For the former, the explanation would be that superheating causes the silicate particles to separate, to some extent, from the metal, so reducing the amount and possibly the size of the slime particles, which in turn reduces the number of nuclei which may form starting points for graphite precipitation. For the latter theory, it is supposed that the non-metallic particles, under certain conditions, become coated with envelopes of slag which is still fluid when the metal has solidified, and so does not innoculate the melt in the same way as truly crystalline particles do.

The author's personal view of these explanations is that possibly both of them can be applied individually to differing conditions and characteristics existing in pig-irons, etc. In this connection it is of interest to record that Joseph and Boegehold[26] found that certain pig-iron produced from blast-furnace mixtures containing a certain proportion of a high-phosphorus, high-titanium ore, when used for making blackheart malleable, caused the castings to possess a coarse and speckled fracture, and to be inferior in mechanical properties. Only by removing this particular ore from the blast-furnace burden was the difficulty overcome. Another interesting fact revealed by these investigators was that, in general, the pig-irons which caused "speckled" fracture were made with slags high in alumina and total acids.

As previously stated, the several investigations, theories and views previously expressed tend to confirm the author's views on the subject of variables in pig-iron properties or characteristics, namely, that more knowledge of composition or composition-fracture control is not always sufficient to control the quality of metal for malleable castings, and that it is advisable for the malleable founder to know the history of the pig-iron, etc., he uses.

Some large American plants have, for a number of years, appreciated such a view, and have arrangements whereby one of their metallurgists is always very closely associated with the blast-furnace plants which supply their iron.

Concerning pig-iron considerations, the remarks made in regard to the presence of chromium in steel scrap also apply to pig-iron. All hematite pig-irons contain some chromium. Peace[27 28] examined many brands of hematite iron, including British, American, Indian and Swedish, and found none free from this element, although the contents of American irons were, in general, lower than British irons. The British irons used by the author for blackheart castings have chromium contents varying from 0.014 to 0.02 per cent.

Machine-Cast Pig-Irons

The growing use of machine-cast pig-iron represents a further development in materials available for the malleable founder. Such iron has the advantage of being more uniform in shape and weight than sand-cast iron, and, as it is free from sand and dirt, it is more economical to use since one pays for iron only.

Another development in raw material, which is of particular value when using cupolas as the melting unit, is the introduction of briquettes for making additions of silicon, manganese, etc., to the furnace charge. These briquettes are made by compounding a definite amount of silicon or manganese with a cement-like binding material. They are moulded to a definite shape and weight, and their use provides a very simple way of making metal composition adjustments. It is also economical practice, for these briquettes do not disintegrate, and only melt when they are close to the melting zone; this reduces considerably silicon loss.

METHODS OF MELTING

There are many methods of melting iron for malleable castings, and the general procedure of such processes is so well known that it is the author's intention only to consider most of them briefly, except in cases where modern developments lend added interest. It may, however, be helpful to set down the different types of melting media in use, though it will be appreciated that many melting practices may involve the use of more than one of these furnaces:—(1) The crucible; (2) the cupola; (3) the open-hearth furnace; (4) the electric furnace; and (5) the rotary, pulverised-coal-fired furnaces.

The Bessemer converter has also been used as an adjunct in some methods, and the same applies to the more modern gas-fired rotary furnace. It is an interesting fact that, if one studies the history and developments of the methods of malleable melting practice, it will be found that it embraces almost the entire history of metal melting.

The Crucible

The crucible is the oldest melting medium employed in the malleable industry, and it is still used by quite a number of small foundries on the Continent and in England. Considering capital cost only, crucible melting is the cheapest; on the other hand, production and working costs are relatively high, and the output is very limited.

Cupola Furnace

The initiation of the cupola is usually attributed to that well-known English foundryman, John Wilkinson, but it would be more correct to say that it was gradually evolved from the early blast furnace and its many modifications. The first English record of cupola charging practice—that of charging alternate layers of pig-iron and coke—is a British patent granted to John White in 1824.

The cupola method of melting is applied to the production of both whiteheart and blackheart malleable iron, and, although its application to the making of the latter type of iron is not nearly so extensive as other furnaces, it still produces by far the major portion of the world's output of whiteheart iron.

Many disparaging views have been expressed concerning the cupola, but there can be no doubt that this process has some very valuable advantages, even if they are offset to some extent by the greater difficulty of obtaining metal of uniform composition than is the case with other

types of melting units. It may be as well to set down some of the advantages of cupola melting:

(1) With the exception of the crucible furnace, the capital cost of the plant is lower than any other melting plant.

(2) It is the quickest method of melting.

(3) When considered from the practice of melting only, it is the cheapest method. The low melting cost is taken advantage of in the duplex and triplex methods, which will be referred to later.

(4) With the exception of the electric furnace, the cupola has a higher possible thermal efficiency than any other melting unit. This efficiency ranges from 35 to 45 per cent.

(5) Properly controlled practice will give a continuous supply of hot and—what is more important—exceptionally fluid iron.

(6) Cupola melting is eminently suitable for foundries requiring a continuity of metal supply over long periods of time.

(7) Metal can be ready for pouring in 15 to 30 minutes after commencement of operation.

Further, it should be borne in mind that if users are prepared to give as much care and thought to control as are normally given to other melting processes, the quality of cupola metal can be very much enhanced. For example, it is the author's experience that most whiteheart founders persist in the deleterious habit of forcing more air into the furnace than is necessary, which results in oxidised iron, lacking in fluidity or "life."

Fundamentally, the general design and method of operating the cupola have not altered during the past 100 years or more. There have been countless patents relating to design and practice almost since its inception, but most of them have become obsolete. The main modifications have been brought about more by evolution than sudden changes. The height, for example, has been gradually increased, and the design and arrangement of the tuyeres have undergone slow changes. Again, improved melting practice with the cupola has followed gradually on the development of knowledge of many subjects, which range from those concerning the engineer who produces these furnaces, the producers of refractories, coke, etc., to those of the operator or to the metallurgist responsible for its operation. The latter's knowledge of all appertaining to efficient fuel combination, etc., to give fluid and clean molten iron as economically as possible, is rapidly increasing.

The Balanced-Blast Cupola

The most outstanding British development of the present century in regard to the cupola furnace was the introduction, about seven years ago, of the Balanced-Blast cupola and system of operation, by J. E. Fletcher. The design and system are universally patented by the British Cast Iron Research Association. It is not possible in a Paper of this type to give any detailed consideration to this method of melting, and the author would refer anyone who is further interested, to Papers by Wharton[29], Buchanan[30] and the present author[31 32].

The rapid and continued success of Fletcher's system is strikingly illustrated by the fact that, within the course of about six years, approximately 140 Balanced-Blast cupolas, with a total hourly melting capacity of over 1,000 tons, have been installed in Great Britain, Australia, India, France, Germany, United States of America, Denmark, China and Czecho-Slovakia. The author has used one of these furnaces for five years for the melting of iron for malleable castings.

The following notes and Fig. 1, which shows the Balanced-Blast cupola in the malleable plant with which the author is associated, will give a brief idea of the system and design. With regard to its inception, Fletcher has stated that he "started out with the idea and conviction that air control should restrict the air supply to the lower part of the coke bed, so as to limit the amount of free air or oxygen of the gases in this zone to the lowest practicable percentage and, at the same time, to maintain the optimum carbon monoxide contained in these gases."

This authority was the first to realise that to obtain and maintain a properly balanced atmosphere such as he required, would necessitate a specially-designed cupola, especially in respect of the tuyeres, for all of these required to be

Fig. 1.—The Balanced-Blast Cupola.

adjustable in order to obtain the correct balance of air between the main lower tuyeres and the auxiliary upper tuyeres.

The tuyere arrangement consists of a lower row of main tuyeres and valves and two or three rows of auxiliary tuyeres. The important feature of the former is that they are controlled by adjustable screw valves which enable the size of the blast inlet of the tuyere to be altered so as to obtain the required adjustments. The auxiliary tuyeres are also adjustable. The whole

Fig. 2.—Drop-Bottom Type Bucket used for Mechanically Charging a Cupola.

of this arrangement permits maximum elasticity of adjustment, operation and control, combined with excellent efficiency as regards coke consumption and quality of metal.

Much progress has been made in the direction of producing low-carbon metal from the cupola. In this connection steel scrap mixtures, already referred to, have an important influence. Kluystman's Paper on the subject has been mentioned, and Stotz[33] has also contributed some very valuable information. Corselli patented a method of producing low-carbon metal and, at one time, it obtained some prominence as it enabled carbon contents of about 2 per cent. to be obtained. However, the difficulty of handling such iron to make castings successfully tended to react against its general use.

So far as the effect of melting practice is concerned with carbon control of a given mixture, the subject resolves into carbon pick-up control. The main factors affecting carbon pick-up are:—(1) Reactivity of coke; (2) height of coke-bed, (3) variations in coke-bed height; (4) temperature of melting zone, and (5) air volume and pressure. The greatest amount of pick-up occurs in the melting zone. The higher the temperature the greater will be the carbon absorption and, therefore, other factors being equal, the higher the melting zone temperature the greater will be the pick-up. Dense cokes of low reactivity give lower carbon absorption than the light, open, high-reactivity cokes.

Raising or lowering the effective coke-bed height (*i.e.*, the height from the tuyeres upwards) materially affects the carbon content of the metal, as is well known. In other words, the higher the coke-bed the greater is the amount of incandescent coke through which the iron has to pass and, in general, the greater is the absorption.

Summarising the above in the light of practical requirements it will be seen that to produce metal of a required carbon content and to keep this element as constant as possible—assuming a suitable mixture and coke requirements—one must carefully control the height and condition of the coke-bed, so that it varies as little as possible during the melt. Air volume and pressure must also be correct and as constant as possible. All the above factors are of vital importance to the malleable founder employing the cupola as his melting medium.

Another important development made in cupola melting was the introduction of mechanical charging. The author favours the "drop bottom" bucket type shown in Fig. 2.

Progress in the direction of measurement and control of air supply is well illustrated by the most modern practice of weighing and controlling the amount of air in respect to its oxygen content. Crawford [34] has clearly shown that the quantity of air required to melt one ton of iron may vary from 30,000 to 20,000 cub. ft. depending upon the atmospheric variations, and that for best practice the air should be measured by weight and not by volume, in order that the supply of oxygen shall be kept constant.

Cupola Blackheart Malleable

Published information relating to cupola blackheart malleable is not nearly as plentiful as that appertaining to the manufacture of cupola whiteheart malleable. Papers or articles by the following probably cover all the available information:—Kluystman,[35] Cole,[36] Herman,[37] Gilmore,[38] Stotz,[39] Riggan,[40] and the present author.[41]

The manufacture of genuine blackheart malleable by direct cupola melting was at one time considered to be almost impossible. Whilst there are few, if any, plants producing this type of malleable which has properties equal to that obtained by the more orthodox methods, such as air-furnace practice, the application of modern metallurgical knowledge to cupola practice has resulted in a number of manufacturers in U.S.A., Germany and France, and also one or two in England, producing from cupola melted iron, blackheart material of very good physical properties. In a few cases these properties are comparable with one of the American specification requirements, whilst almost all the plants are able to comply with the present British Standards Institution specification for blackheart malleable.

It has already been mentioned that the cupola is an excellent medium for supplying molten metal of suitable fluidity in foundries engaged

in continuous production of light malleable castings, such as pipe fittings. Cupola blackheart metal possesses physical properties which make it particularly suitable for such castings and other parts which may be required to possess rigidity coupled with the necessary ductility. The high and almost constant yield point value expressed as a percentage (70 to 75 per cent.) of the ultimate tensile strength is characteristic of very tough metal which meets with such requirements.

A practical example of the manner in which this type of malleable resists internal pressures is found in the fact that pipe fittings of about 1 in. dia. and a wall thickness of $\frac{1}{8}$ in. or slightly less, will not fail under hydraulic tests until pressures of 8,000 to 9,000 lbs. per sq. in. are attained. The physical properties, as given in the several references quoted, range as follow:—Ultimate tensile strength, 18 to 20 tons per sq. in., and elongation on 2 in., 7 to 15 per cent. The yield point of 20-ton tensile, 10 per cent. elongation metal was 14.5 to 15 tons.

The average results of another plant producing cupola (direct) melted blackheart malleable castings are given as:—Tensile strength, 21.5 tons per sq. in.; yield point value, 15.2 tons per sq. in., and elongation on 2 in., 11 per cent.

Lower carbon malleable made by the air furnace or similar methods usually possesses lower yield values than cupola material, but higher elongation values or ductility.

According to the "Cast Metals Handbook," published by the American Foundrymen's Association in 1935, 8 per cent. of the malleable plant capacity of America is represented by cupola-melted iron. Other methods in which the cupola is used as adjunct with some other type of furnace bring the total percentage to about 22.8 per cent. of the total capacity. In Germany, direct-melted cupola blackheart metal formed 49 per cent. of the total output for 1930, the Brackelsberg rotary furnace being next with 25 per cent.

Duplex and Triplex Melting Processes

One of the main disadvantages of cupola-melted metal, apart from the difficulty of producing a uniformly low carbon percentage in the metal, is the relatively high sulphur content which results. The detrimental effect of excess sulphur or excess manganese sulphide on the physical properties of blackheart malleable is well known. A consideration of developments in which the aim has been to produce the highest quality metal and yet utilise most of the advantages which are associated with cupola melting is therefore needed.

So far as melting for whiteheart malleable cast iron is concerned, duplex melting processes were being experimented with in France and Germany nearly 25 years ago. The methods adopted were that of cupola melting and refining and reheating in a kind of oil-fired receiver or furnace. One process involved treatment of the molten cupola metal in a Bessemer converter in order to reduce the carbon and silicon to the required amounts. The oil-fired furnace of about this time was also used in an attempt to melt the iron; this was not altogether successful or economical, though the method has proved to be the forerunner of the present rotary furnaces which are so successful.

There are definite indications that the manufacture of whiteheart metal by duplex systems is decreasing, and in view of the advent of the rotary furnace there seems little likelihood of the duplex methods regaining lost ground in this industry. Duplex processes for the manufacture of blackheart malleable cast iron are in use in several foundries in U.S.A., and there is at least one foundry in England operating on these lines. Two of the most successful duplex methods employed for this type of metal are:—(1) Melting in the cupola and refining in air or reverberatory furnaces, and (2) cupola melting, partial refining and superheating in the electric furnace. These methods result in appreciable saving in melting time and costs.

The procedure in one American plant is to tap the metal from a cupola into the rear end of an air furnace. It is claimed that the adoption of this method enabled the metal output to be doubled without having to increase the size of the air furnace. The air furnace used alone takes 4 hrs. to melt a 20-ton heat; the duplex process produced the same amount in $1\frac{3}{4}$ hrs. Statistics show that some 7 per cent. of the U.S.A. output is manufactured by the cupola-air furnace process. An English foundry is employing cupola melting and open-hearth refining; this method is somewhat more economical than the cupola-air furnace process on account of the greater thermal efficiency.

The Electric Furnace and Triplexing

The advent of the electric furnace has also had a definite influence on the development of the malleable industry. Its connection with the manufacture of malleable castings dates back about 20 years. Probably the first successful application of the electric furnace was the production of blackheart malleable by a triplex process (cupola—converter—electric furnace) devised by W. E. Kranz in 1913-14.

T. Levoz[42] obtained, in 1915, a French patent relating to a triplex method involving the use of a cupola, side-blown converter, and an electric or heavy-oil furnace. Merrick[43] recorded particulars of a duplex process whereby cupola-melted iron was partially refined in an electric furnace. It was claimed that this method permitted the use of more scrap.

The Kranz Triplex Process

This method, described in detail by Schwartz in his treatise "American Malleable Cast Iron," was used for many years by the National Malleable & Steel Castings Company, of the U.S.A. Briefly, the procedure was as follows:—The iron was melted in a cupola (a typical charge would consist of 4 to 5 per cent. pig-iron, 40 per cent. sprue and hard scrap, and 54 to 55 per cent. annealed scrap), and a portion of the cupola metal was treated in a side-blown converter to reduce carbon and manganese. Then correctly proportioned amounts of the latter metal plus cupola metal, both in the molten state, were transferred to Heroult arc-type furnaces of 6 to 15 tons capacity. The latter operation involved removal of sulphur and oxygen, and increasing silicon, carbon and manganese to the required amounts, and, finally, heating to the required pouring temperature.

Desulphurisation was achieved by treatment of the iron with a slag formed from limestone, fluorspar and coke. After removal of oxygen, calcium carbide is formed, and this carbide reduces the metallic oxides, releasing iron and forming, in addition, carbon monoxide, according to the reaction, $3FeO + CaC_2 \rightarrow 3Fe + CaO + 2CO$. Calcium sulphide is also formed through reaction of carbide with the sulphur present in the metal; during this stage it is essential to maintain a reducing atmosphere; otherwise, the calcium sulphide is oxidised into calcium oxide and the sulphur passes back into the metal.

There are a number of serious disadvantages associated with this triplex method. In the first place, the capital cost for plant is very heavy; further, the process is not suitable for intermittent operation, and efficient and economical results are only obtained when the plant can be operated continuously for 24 hours. The author believes that the process is not now in use.

The General Motors Corporation Duplex Method

In the light of present knowledge, it can be stated that the cupola-forehearth-electric furnace duplex method, which is operated at the Saginaw (U.S.A.) malleable foundry of the General Motors Corporation, represents a distinct advance over the Kranz process, and is certainly the most efficient duplex method, involving the electric furnace, of the present time. It is much easier to carry out the various operations than is the case with the Kranz method; for instance, desulphurisation is simpler. Capital costs are also lower, and the method has the very decided advantage of enabling continuous pouring to be employed, and yet yields economic working without the necessity for 24-hr. operation. B. R. Mayne,[44] general manager of this plant, described the procedure in an excellent Paper to the American Foundrymen's Association a few years ago.

The process consists of melting the iron in cupolas, each of 20 tons per hr. capacity, and fitted with 10-ton capacity tilting forehearths. The cupola charges comprise 10 to 12 per cent. pig-iron, 38 to 40 per cent. steel scrap, and 50 per cent. foundry scrap and sprue. As the metal flows from the cupola into the forehearth it comes into contact with soda ash placed in the launder, spout or channel connecting the furnace with the forehearth. Continuity of metal supply is assured by transferring 10 tons of forehearth metal to each of two (10 to 12 ton molten metal capacity) electric arc furnaces. When the metal reaches 1,600 deg. C., approximately, three tons are taken from one of the electric furnaces and poured into the production moulds. Three tons of forehearth metal are then added to the seven tons left, and then three tons are taken from the second electric furnace and poured into castings; meanwhile, the metal in the first furnace is again being heated to the required temperature.

The amount of soda ash is given as 6 lbs. per ton of metal, and the sulphur reduction 20 per cent. after 1 to $1\frac{1}{2}$ hrs. contact. To the author the extent of sulphur decrease is low, especially considering the length of time the soda ash is in contact with the iron. It is no doubt explained by the fact that the quantity of desulphuriser used—which is 0.3 per cent. by weight of metal—is very low. This procedure continues throughout the day, and Mayne records that as much as 425 tons of metal have been poured in his plant during one day of 10 hrs. The current consumption for full-capacity operation is stated as varying from 92 to 98 k.w.h., which includes melting a 5 per cent. addition of solid steel scrap. Carbon content of the metal as cast is 2.6 to 2.8 per cent.

The Saginaw duplex process has been proved most satisfactory especially where a continuous moulding and pouring system is in operation, for it enables the supply of molten iron to be varied, according to requirements, up to 40 tons or more per hour. The air furnace is not easily adaptable to such a continuous scheme, and its costs per ton of metal melted are appreciably higher than with the aforementioned process. According to "Cast Metals Handbook," cupola-electric duplexing accounted for 100,000 tons, or 7.6 per cent. of the annual capacity of American malleable plants.

To conclude this section, the author will summarise the relative positions of the triplex and duplex methods of melting in the malleable industry by stating that the former method represented a development of twenty years ago; while one or two of the latter represent further and much more efficient developments of the past ten to twelve years. These latter processes have resulted in increased and continuity of production at less cost.

The Air Furnace

Consideration of air-furnace practice for malleable iron melting is a very interesting study, but the extent of this Paper does not permit detailed reference. The name—air furnace—is given to the reverberatory type of furnace of the non-regenerative class, to distinguish it from the open-hearth furnace of the true regenerative type. As is well known, air-furnace melting is, up to the present time, the predominating practice for the manufacture of blackheart mal-

leable cast iron. It represents about 70 per cent. of the plant capacity of America, while the greatest tonnage of blackheart malleable made in Great Britain is produced from air-furnace iron. This method is also used in France, but according to Stotz it is not employed in Germany, nor, so far as the author can ascertain, is it applied to the making of whiteheart malleable. The furnace sizes have ranged from ½ to 40 tons capacity, but progress in the knowledge of its use indicates that the most efficient performance is obtained from furnaces of 15 to 25 tons.

The early air furnaces were coal fired by hand, and quite a number are still fired manually, the coal used being hard and bituminous. At one time natural draft created by a suitably sized stack was used, but for many years forced draft has been employed.

Refractories represent a considerable item of costs in air-furnace practice; according to Schwartz every ton of iron melted destroys 30 lbs. or more of bricks, etc. During the past fifteen years much progress has been made in the manufacture and use of refractories. For example, whilst silica sand is still used by many plants for making up the bath bottom, firebrick bottoms are rapidly gaining favour, the bricks being set in high temperature (aluminous) cement.

Modern practice has tended towards the use of high (40 per cent. or more) alumina firebricks for side walls. There has also been considerable development in their design and materials of construction of roof-bungs. Bung bricks should be rather softer than those used for the side walls, but mechanical strength must be borne in mind. Usually, a higher silica and lower alumina brick is most suitable for the bungs where a good quantity of ash is carried along with the gases. The lower alumina brick glazes more easily and, in consequence, gives, in general, longer life. There are many other considerations which have to be remembered when deciding on the suitability of refractories; one more example is considered worth quoting, for it is directly related to a section of refractory research which is still being carried out.

Effect of Reducing Atmosphere on Refractories

Furnaces operating with an atmosphere which is reducing in character for any length of time are likely to suffer from severe refractory losses, due to the disruption of some of the brickwork, which is brought about by the action of carbon monoxide. Some firebricks are completely crumbled or disrupted in the presence of carbon monoxide at temperatures as low as 400 deg. C. Failure is brought about by the decomposition of the carbon monoxide into carbon and carbon dioxide, resulting in the former being deposited in the pores of the bricks; on repeated heating this carbon grows and causes the bricks to crumble. The reaction is said to be accelerated by the presence of catalysts such as iron, and especially iron compounds. Investigations have shown that carbon monoxide disintegration is associated with the iron oxide—or "iron spots"—and the complex iron constituents, not with the total iron. Hard burning tends to reduce carbon monoxide attack, as it enables the iron compounds to react with the clay more thoroughly.

Reverting to air-furnace practice, the constituents of the metal charges vary very appreciably, but the following indicates typical practices:—Pig-iron, 30 to 45; sprue, foundry scrap and annealed scrap, 45 to 60; and steel scrap, 5 to 15 per cent. For hand-fired furnaces, coal consumption amounts to 0.4 to 0.5 tons per ton of metal melted. The application of pulverised coal-firing to air furnaces is of comparatively recent origin, dating back only 15 to 16 years, but it has been very rapid; this is proved by the fact that 57 per cent. of the tonnage capacity of American malleable plants is now represented by pulverised fuel practice, while hand firing amounts to only 13 per cent.

The dimensions and capacities of pulverised fuel-fired air furnaces are very similar to those of hand-fired ones. E. F. Wilson[45] described the design, construction and operation of a 15-ton furnace of this type in a Paper presented to the American Foundrymen's Association, and the author would strongly recommend anyone interested to study Wilson's Paper, as it presents modern practice in a very lucid manner.

Moisture content of the coal is an important factor, and the degree of pulverisation must be carefully controlled, as efficiency of operation depends to a very large extent upon coal particles being ground within definite limits of size. Wilson quoted a fineness standard of 80 to 85 per cent. through a U.S.A. standard 200-mesh sieve. The coals used are similar in composition to those given for hand-fired furnaces. Fuel consumption varies appreciably, and figures of 0.25 to 0.4 ton per ton of metal melted have been quoted by several authorities. It is of interest to note that the lower figure is associated with very good American practice. The greater ratio of metal to fuel usually obtained, as compared with that of hand firing, is largely due to the fact that in pulverised fuel practice much less excess air is admitted to the furnace. A melting rate of approximately 30 min. per ton represents good practice.

Oil firing of air furnaces has not been adopted to any great extent, though it might be mentioned that the Saginaw plant previously referred to operated four oil furnaces prior to their change-over to the duplex method. One of the main disadvantages of oil firing is the difficulty of maintaining an atmosphere reasonably free from excess air or carbon dioxide.

Concluding the considerations of air-furnace practice, there is little doubt that this method of melting is one of the most expensive, and certainly the least efficient (judged from a thermal efficiency standard) of all melting units.

(To be concluded.)

Iron and Steel Production

The British Iron and Steel Federation reports that there were 126 furnaces in blast in the United Kingdom at the end of July, compared with 126 furnaces at the end of June, four furnaces having been blown in and four furnaces having ceased operations during the month, one of which was temporarily damped down. The production of pig-iron in July amounted to 729,300 tons, compared with 699,300 tons in June and 665,600 tons in July, 1936; the month's production includes 183,200 tons of hematite, 396,000 tons of basic, 118,000 tons of foundry and 15,600 tons of forge pig-iron. The production of steel ingots and castings in July amounted to 1,059,200 tons, compared with 1,106,400 tons in June and 974,100 tons in July, 1936.

(Concluded from next column.)

Middlesbrough (Councillor G. Carter), and the chairman, vice-chairman and members of the Reception Committee.

It is expected that the following Papers will be discussed:—Special Report No. 18, (5) and (4).

THURSDAY, SEPTEMBER 16, AT 10 A.M.

General meeting in the Hall of the Cleveland Scientific and Technical Institute. It is expected that the following Papers will be discussed:—(1), (2), Special Report No. 19, and (if time permits) (9).

The remaining Papers will be taken as read, and written contributions to the discussion are invited.

Iron and Steel Institute

AUTUMN MEETING

The Autumn Meeting of the Iron and Steel Institute, as announced in our issue for July 15, will be held in Middlesbrough from September 14 to 17. The original programme has been amended as follows:—

Mr. Benjamin Talbot (chairman of the Middlesbrough Reception Committee) has expressed the hope that members of the Institute, as well as ladies, will accept his invitation to attend a garden party, at Solberge Hall, Northallerton. In order to make this possible, the date of the garden party has been altered from Thursday, September 16, to Friday, September 17. Ladies' excursion on Thursday, September 16, will now consist of a motor drive through Bilsdale, lunch on the terrace at Rievaulx and visit to the ruins of Rievaulx Abbey. The return journey will be made over the Yorkshire Moors. The excursion on the River Tees is limited to ladies, and will take place on Friday morning, September 17, instead of the afternoon of that day. The excursion to Whitby on Wednesday, September 15, is now open to members as well as ladies. Members wishing to take part in this excursion, instead of visiting works, should notify the secretary.

The following is a complete list of the Papers to be presented at the meeting:—

Special Report No. 18.—"Reports upon Blast-Furnace Field Tests. I.—An Investigation of a Blast-Furnace Smelting principally Lincolnshire Ores at the Frodingham Works of the Appleby-Frodingham Steel Company, Limited." By the Blast-Furnace Reactions Research Sub-Committee of the Iron and Steel Industrial Research Council.

Special Report No. 19.—"Foamed Blast-Furnace Slag." By T. W. Parker (being a Report of the Slag Tests Panel to the Blast-Furnace Committee of the Iron and Steel Industrial Research Council).

(1) "Some Experiments in a Small-Scale Cupola," by H. E. Blayden, W. Noble and H. L. Riley.

(2) "The Influence of Carbonising Conditions on Coke Properties. Part I, Mechanical Pressure," by H. E. Blayden, W. Noble and H. L. Riley.

(3) "The Mechanism of Nitride-Hardening," by M. S. Fisher and Z. Shaw.

(4) "Hot Metal Practice in Five Melting Shops on the North-East Coast," by W. Geary.

(5) "The Thomas-Gilchrist Basic Process, 1879-1937," by Frank W. Harbord, C.B.E.

(6) "Variation in Thickness of the Tin Coating of Tinplate, and Its Effect on Porosity," by W. E. Hoare.

(7) "Some Alloys for Use at High Temperatures. Part IV, The Constitution of the Alloys of Nickel, Chromium and Iron," by C. H. M. Jenkins, E. H. Bucknall, C. R. Austin and G. A. Mellor.

(8) "Further Experiments on the Nitrogen-Hardening of High-Chromium and Austenitic Steels," by B. Jones.

(9) "A New Method for Judging the Behaviour of Iron Ores during Reduction," by N. J. Klärding.

(10) "Some Notes on Recent Experiments in Connection with the Spraying of Steel by the Wire-Fed Metal-Spraying Pistol," by Richard R. Sillifant.

Programme of Sessions

WEDNESDAY, SEPTEMBER 15, AT 10 A.M.

General meeting in the Hall of the Cleveland Scientific and Technical Institute. Welcome to the Institute by His Worship the Mayor of

(Concluded in previous column.)

Foundry Selling Practice

THE FILM AS A SALES MEDIUM

By ERIC N. SIMONS

Little attention has been paid by the foundry industry as a whole to the sales possibilities of the cinematograph film, and especially of the "talkie." Individual firms have done some good work in this direction, but these are in the minority. The original form of film salesmanship was comparatively simple. Silent films, often primitive in method, but relatively cheap, were made, and lent to various bodies for display; or in certain instances representatives called upon buyers with complicated projectors and endeavoured to persuade them to witness a film demonstration in their own offices.

The major factor which hindered film salesmanship was the silence of the film, and its relative mediocrity from the technical point of view. No amount of clever interpolation of titles into a film reel could satisfactorily explain to the person seeing the film the exact meaning of the scenes displayed, and he could not help missing a great deal. Secondly, the art of the industrial film was so little understood that the films were almost incredibly bad. Scenes were filmed in foundries without any provision for proper lighting. *Montage* (constructive editing) was unknown, and the number of firms merely out to make any film, no matter how poor, for as much of the founder's money as they could coax out of him, was legion.

The consequence was that foundries which had spent a great deal on films for sales and publicity purposes discovered that they were not getting results in return. Furthermore, the portable projectors of those days were clumsy and complicated, often leading to misadventures before the amateur operator could begin his display.

Industrial Film Developments

To-day, not only has the "talkie" film attained a high degree of perfection, and projectors become far more efficient and inexpensive, but there has steadily grown up a whole art of film-making for industrial purposes that tends to make commercial films not only valuable as aids to sales, but also of extreme interest and importance intrinsically. This being so, it is important that the founder should not neglect the possibilities of film salesmanship, and for this reason it is necessary to indicate how to utilise it. In the first place, the founder will have to know clearly what he wants from film salesmanship, and these are the functions from which he must choose:—(1) A film, popular rather than technical, to appeal to the general public, and intended to be shown in cinemas at home and abroad; (2) a film for utilisation as an adjunct to lectures by the foundry staff: (3) a film for loan to engineering societies, technical colleges, and the like, without the accompaniment of a skilled lecturer; (4) a film for exhibition by salesmen or representatives either in buyers' own offices, or to assembled groups of buyers in cinemas hired for the occasion; and (5) a film of educational function exclusively, designed to produce better treatment or handling of the foundry product.

One film obviously cannot serve all these purposes, and as films are expensive to make, it is wise to decide beforehand what the object of the film is to be. This will save a great deal of time, and prevent disappointment when it is found that a film for (1) cannot be used for (3) or (4). This choice of treatment is very important because the object of the film governs the size of film to be used, whether projectors and screens are to be bought or sound to be employed or not.

Expert Advice Needed

The founder whose knowledge of film salesmanship, and the film world generally, is slight, is recommended to interview a film consultant, who will advise a founder on every aspect of industrial film salesmanship and publicity, and will not charge him any fee for so doing if he does not, in the end, decide to embark upon a film. The writer's personal experience is that the consultants will go to much trouble to equip a founder with all the information and help he requires. If the film is embarked upon, their fee may prove relatively high; but as this fee will almost certainly include technical direction of the making of the film, it is well worth while. Their knowedge of the capacities and reputations of the various film companies handling industrial films will be found of great value.

The preliminary talk with the consultant will probably decide what the film shall do, and here it is essential to indicate certain aspects that should be considered. The film for the general public is only suited to a firm which sells a nationally usable product, or which has a nationally known name. Films of this kind often begin with historical scenes illustrating the origin of the products, and end with scenes illustrating its modern development, manufacture, and use. The amount of direct mention of the issuing firm must necessarily be reduced to a minimum, or the public will resent having the film thrust upon it as part of their evening's entertainment, Where such films have been made, they have succeeded because of their intrinsic interest, and because of the artistic method of their making. They are costly, and few foundries need contemplate them, but they have this one important advantage, namely, that if the film is good enough, the provincial theatres will rent it, and pay for the privilege, which goes a long way towards off-setting the film's first cost.

Silent Films Seem Old Fashioned

The foundry will mostly have to choose films of the types (2) to (5). The film (2) for utilisation as an adjunct to technical lectures has serious limitations. In the first place, since the lecturer is there in person, there is no real need for a "talkie" film; anything the titles do not explain, he can explain himself. In consequence, a silent film is as good for this use, and is, of course, much cheaper. On the other hand, it suggests that the foundry is "out of date." It can never be so explanatory and dramatic as the "talkie," and it tends to be tucked in at the last moment.

The film (3) for loan to various societies is important, and here, certainly, the "talkie" film should be employed. If a master film is made, cheap copies can be obtained from it, and these can be circulated, so that as many as three or four different institutions may be showing the same film at the same time. Obviously, no foundry could afford to have as many lecturers touring the country every few days. The number of technical bodies that would welcome a film of this kind as an adjunct to their meetings is much larger than is usually imagined, and while many of these bodies have their own apparatus for the reproduction of films, others are quite prepared to hire equipment if they can get a good film. Without at the moment considering the actual theme or subject of the film when made, the point to bear in mind is that having secured a film for purpose (3), it should be actively "pushed." Societies and other bodies should be circularised and asked if they would care to show the film; its subject should be stated and its details of size, etc., indicated. Railway shops in various centres, engineering firms possessing clubs and organisations to which films could be shown, universities possessing technical branches and technical groups of all kinds could all be approached on these lines, and a considerable proportion would be found willing to let their members see the film.

Certain bodies would be unable to show "talkie" films, either because they did not possess or could not borrow the necessary apparatus. Here, as in connection with (4), the founder must decide whether or not he considers the advantages to be gained from film salesmanship warrant the purchase of a projector or projectors, which could be lent to bodies where necessary, or which could be employed by the foundry salesmen for demonstration purposes.

The Individual Sales Film

The film (4) exclusively for sales use has a great deal to commend it, but it must be handled quite differently from the other types of films. Without embarking upon a consideration of the scope and purport of industrial films, it is well to review the advantages from a selling point of view of films of the (4) type. The principal argument against them is that they inevitably demand two things: (*a*) efficient transport for the film, its projector, and its operator; (*b*) willingness on the part of the buyer to devote at least a quarter of an hour and the whole of his office to a film demonstration. This is why so many users of industrial films as salesmen adopt the policy of inviting all the buyers in a particular district to attend a film show in the cinema proper. This means, however, that the film, to be worth showing at all in this way, must run for at least an hour, and is apt, therefore, to be costly. On the other hand, these films are amazingly effective. They present points lucidly, clearly and entertainingly. They have enormous prestige value, and they do what no mere verbiage can do, supplement the buyer's imagination. On the screen, whether in his own office or elsewhere, he can see for himself.

Catalogue Received

Foundry Equipment. The Coggon Foundry Equipment, Limited, of Shay Lane, Ovenden, Halifax, has sent us a folder containing a number of loose leaves, to be added to from time to time. These cover a number of interesting phases of foundry equipment, and after outlining the scope of the firm's productions, illustrated descriptions of portable and fixed drawer type core stoves are given. This is followed by some general notes on core and mould drying, and some illustrated details of a portable unit. Core sand mixing and handling plant is covered in two pages by illustrating and describing a plant installed on the North-East coast. An entirely different installation is detailed for the preparation of core and facing sand. Descriptions of iron reclamation from foundry sand, two annotated pictures of a sand transporting system, and an aerator complete this section. A page is devoted to the mechanical production of cores, and then a return is made to core sand facing mixing. Finally a description of a continuous core drying stove is given. It is apparent that at this stage no importance is to be attached to the order in which the various leaflets have been placed, but we would suggest that in future the various cognate types of plant be grouped, as it is just possible that one might be looking for a continuous core stove and failing to see it detailed amongst the other types imagine that this section was not catered for. The binder with the loose leaves are available to our readers on request, and as many new designs are disclosed we recommend that foundrymen should avail themselves of this offer.

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This Week's News in Brief

Trade Talk

R. & A. MAIN, LIMITED, are to extend their Gothic Ironworks at Camelon.

G. & R. THOMAS, LIMITED, Hatherton Blast Furnaces, Bloxwich, Staffs, have restarted their No. 1 furnace following re-lining.

C. A. PARSONS & COMPANY, LIMITED, of Newcastle-upon-Tyne, have received a contract for a 15,000 kw. turbo-alternator and condenser from the City of Regina, Saskatchewan, Canada.

THE EMPLOYEES of the Singer Manufacturing Company, Limited, Clydebank, are to receive from August 20 a 5 per cent. increase in wages. This is the second increase within the past few months to those whose wages do not exceed £6 per week.

THE INSTITUTE OF WELDING will hold its first annual dinner at Grosvenor House, Park Lane, London, on Tuesday, September 21, under the presidency of Sir Alexander Gibb. The principal guest will be Dr. Leslie Burgin, Minister of Transport.

THE MANCHESTER ASSOCIATION OF ENGINEERS is to visit the works of Brocklehurst-Whiston Amalgamated, Limited, silk manufacturers, of Hurdsfield Mills, Macclesfield, on September 8, and those of Renold & Coventry Chain Company, Limited, at Didsbury, on September 18. Those wishing to participate should apply to the secretary of the Association, St. John's Street Chambers, Deansgate, Manchester, 3.

THE L.N.E. RAILWAY COMPANY have decided to reorganise entirely the iron foundry attached to the Cowlairs works, Glasgow. Among new equipment to be installed are a continuous casting plant suitable for handling 120 moulds per hr. and 20 tons of sand; new fettling plant; three mechanically charged cupolas with a capacity of 6 tons per hr. each; new moulding machines, and a new 10-ton overhead electric travelling crane.

IMPERIAL CHEMICAL INDUSTRIES (INDIA), LIMITED, is to float an Indian company for the local manufacture of products essential to Indian industrial development. Factories will be erected in the Punjab for the manufacture of soda ash, and in Bengal for the manufacture of chlorine and caustic soda. It is intended that a large proportion of the capital shall be offered for subscription by the Indian public. Indian labour will be employed, and Indian staff will be trained to share in technical management.

HOLDERS of the 5½ per cent. and 7 per cent. debentures, amounting to £466,000, of Marshall, Sons & Company, Limited, of Gainsborough, have been notified by the solicitors concerned with the winding-up, that after payment of all costs there remains a sum available for distribution among the debenture-holders equal to about 3s. 11½d. for each £1 of debentures. Marshall, Sons & Company was acquired from Thos. W. Ward, Limited, by Marshall, Sons & Company (Successors), Limited, which was registered in March of last year.

A LIMITED COMPANY with the title of Indian Malleable Castings, Limited, has been registered in Calcutta with a capital of Rs. 21 lakhs for the manufacture of malleable castings from indigenous materials. India has hitherto been importing these castings from America, Japan and the United Kingdom, her average annual consumption being about 1,500 tons. A factory will be built seven miles from Calcutta, and will begin production in February, 1938. The estimated annual output of the factory will be 450 tons at the start. The registered office of the company is at 8, Esplanade East, Calcutta.

UNDER THE Midland Iron and Steel Wages Board's sliding scale, wages will be raised from Monday, August 9, by 2½ per cent. During May and June, the period on which wages for the two months now ensuing depend, the average selling price shown by the books of the 18 firms by whose transactions the scale is regulated was £11 5s. 7d., compared with £10 19s. 8d. in the preceding bi-monthly period. The price level was higher than for ten years past. Since June selling prices of finished iron have been advanced by £1 17s. 6d. a ton, automatically involving a further rise in wages. Advances this year, including the 2½ per cent. now declared, have amounted to 7½ per cent., making the rates 45 per cent. above the basis for puddling, other forge and mill wages controlled by the sliding scale being in proportion. The sales of iron by the selected firms aggregated 20,858 tons during May and June, thus maintaining the level previously attained this year.

Personal

COL. A. D. MACINNES SHAW, of Shaw & MacInnes, ironfounders, of Spring Bank, Glasgow, has been elected Conservative candidate for the Springburn division of Glasgow, in which a by-election is shortly to take place.

MR. KENNETH FIRTH, son of Sir William Firth, managing director of Richard Thomas & Company, Limited, received slight injuries on Tuesday when an aeroplane which he was piloting crashed near Shoreham, Sussex, after striking an overhead electric cable.

SIR GUY WRIGHTSON, chairman of Head, Wrightson & Company, Limited, Teesdale Works, Thornaby, has received from 70 old employees of the firm, each with 40 or more years' service, a framed portrait of himself as a token of their esteem. Sir Guy has himself been associated with the company for 41 years.

Will

HUTCHINSON, ALEXANDER, of Lea Foundry, Hancock Road, Bromley-by-Bow, London, E.3 ... ... £19,547

Obituary

THE DEATH occurred recently of Mr. John William Mortimer, a partner of the Ajax Casting Company, Lancaster.

MR. JOHN MACLUSKIE, manager of James Dougall & Sons, Limited, brick and refractory makers, Bonnybridge, died at the age of 39 on August 8.

MR. WILLIAM DAWSON, a foreman employed in the Chatton Foundry of Mitchell, Russell & Company, Limited, Bonnybridge, died on August 7, aged 50.

MR. ROBERT WILLIAM REEVES died on August 7, aged 73 years. He was founder and director of R. W. Reeves, Limited, the Ellesmere Engineering Works, Leigh, Lancashire, and a director of Leigh Foundry, Limited, Plank Lane, Leigh.

DR. WILLIAM RIPPER, formerly a professor of engineering at Sheffield University, and Vice-Chancellor from 1917 to 1919, died last Friday, aged 84. Dr. Ripper was a Past-President of the Sheffield Society of Engineers and Metallurgists, vice-chairman of the Sheffield Committee on Munitions of War and founder of the Sheffield Trades' Technical Societies. He was created a Companion of Honour in 1917.

WE REGRET to announce the death, on July 29, of Major R. A. Bull, one of the foremost steel-foundry metallurgists of the U.S.A. He was well known in this country through his contributions to technical literature. In 1923 he was author of the Exchange Paper presented on behalf of the American Foundrymen's Association to the annual conference of the Institute of British Foundrymen. He was then research director of the Electric Steel Founders' Research Group, and his Paper took the form of a general survey of American steel foundry practice. Major Bull was an honorary member of the American Foundrymen's Association, of which body he was President from 1914 to 1916. He was also a member of the Institute of British Foundrymen (which he joined in 1922), the Iron and Steel Institute, and numerous American societies. He was 63 years of age.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Lancashire & Corby Steel Manufacturing Company, Limited, Corby, Northampton.—Capital, £1,000. Directors: J. E. James, Sir Wm. P. Rylands, R. Paterson, A. C. Macdiarmid, J. R. Menzies-Wilson, and W. F. C. McClure.

NET PROFIT of the International Nickel Company of Canada, Limited, for the three months to June 30 last (in U.S. currency) was $14,199,395, compared with $11,714,957 for the preceding quarter and $9,070,187 for the second quarter of 1936. After allowing for the preferred dividend, the balance is equivalent to 94c per common share, against 77c and 59c respectively. For the first half of 1937 net profit totalled $25,914,352, compared with $17,456,974 for the like period of 1936.

Company Meeting

Davy & United Engineering Company, Limited

The annual meeting of Davy & United Engineering Company, Limited, was held on August 6 at Sheffield. MR. E. J. FOX (chairman), who presided, said that conditions in the home market during the past year had been much better than for a long time past, and although the year had not been without its difficulties, they had been in a position to take advantage of the greater volume of business which was on offer, and this state of affairs was reflected in the accounts. Their export trade was being well maintained. The fundamental object of the company was to supply the most modern type of plant for the service of the iron and steel industry. In recent years one of the outstanding developments had been the introduction of heavy types of cold-rolling mills, and this had been extensively exploited in the United States. There had recently been a growing tendency to adopt this type of plant in Great Britain, and with this in mind the directors decided to link up with the principal American exponents. Negotiations were therefore entered into with the United Engineering & Foundry Company, of Pittsburgh, U.S.A., the result of which was a mutually satisfactory arrangement whereby they had obtained the sole right to manufacture all the products of the American company in the British Empire, excluding Canada. They had been associated for some considerable time with the Morgan Construction Company, of Worcester, U.S.A., in building their continuous mills, and their associations with that company were proceeding. During the year the directors decided that a roll foundry would form a valuable adjunct to the company's business, the products of such a foundry being so closely allied to the main business, and they were fortunate in being able to acquire the whole of the share capital of the British Chilled Roll & Engineering Company, Limited, of Middlesbrough. Steps had been taken to increase the capacity of the works at Middlesbrough, and with the co-operation of their American associates they were manufacturing, in addition to the present range, special rolls of the "Unefco" type, for which there was a growing demand. There was already evidence that this subsidiary company, in addition to acting as a source of supply for the parent company, would in itself prove a good investment. The extensions in Sheffield and in Middlesbrough would shortly be completed. In his address last year he referred to the matter of German competition. They had not been free of this competition during the year, but for various reasons its effect had not been so great. It was apparent, however, that as and when they considered it necessary the German authorities would go to great lengths in subsidising their manufacturers in order to ensure business. It would appear that where credits were required in a foreign country to finance purchases, the German manufacturer, with the assistance of his subsidy, was able to sell at practically any price. In the past, when they had complained of this unfair competition, it had been said that, quite apart from the question of price, their product did not compare favourably with the foreign product. To some extent that might have been so, but in defence he would say that such a state of affairs was not wholly their fault, but could be traced to the general national conditions which existed after the war. It was also the case that little assistance was given to their industry to extricate itself from the position brought on by these conditions, and certainly much less than was given to other industries. But to-day he firmly believed that most authorities would agree that even without assistance they had set their house in order, and by a policy of co-operation and modernisation had achieved a position where the design and quality of their product was not surpassed by any manufacturer at home or abroad. It was only reasonable to ask that the British steelworks plant manufacturer should be protected from subsidised competition. They did not fear competition which was fair and economic, but it could not be in the national interest—far less in the interest of those employed in their industry—that they should be expected to compete against a subsidised product made in a country where the rate of wages was below that prevailing in our own country.

Forthcoming Event

SEPTEMBER 16 TO OCTOBER 2.

Engineering and Marine Exhibition:—Incorporating the Foundry Trades' Exhibition and the Welding Exhibition, at Olympia, London, W.14.

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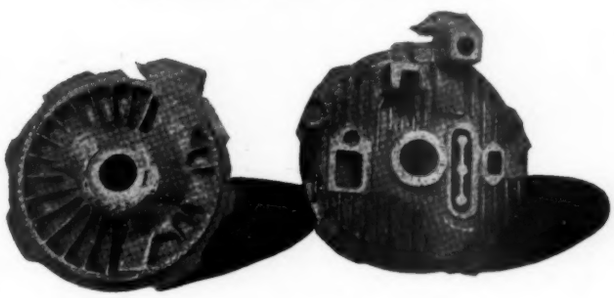

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Raw Material Markets

Although it had been generally accepted that prices would remain at their present levels until the end of the year, it is now suggested that further increases may be made on October 1. Costs of production will be still further raised by the recent decision to advance railway freights. The formation of the Foundry Pig-iron Producers' Association, under the chairmanship of Mr. E. J. Fox, has been announced. This organisation is to be concerned solely with the interests of the foundry and forge pig-iron producers in England and Scotland.

Pig-Iron

MIDDLESBROUGH.—New business in this area is very quiet, owing to the fact that the present output is totally inadequate to meet existing commitments. Deliveries are being made as fast as supplies become available, but arrears are gradually increasing. No. 3 Cleveland G.M.B. is quoted at 101s., No. 1 foundry 103s. 6d., and No. 4 foundry and No. 4 forge 100s., delivered to Middlesbrough and district. The shortage of hematite is causing much inconvenience to consumers both at home and abroad. Small tonnages are being shipped to overseas destinations and some users in this country are indignant that this should be so whilst there is a shortage at home. Generally, however, it is appreciated that producers are wise to accept the advice of the President of the Board of Trade, who recently stated that the export market should not be totally neglected whilst the rearmament programme has still to be completed, as Government orders would not always be available. East Coast mixed numbers are quoted at 122s. 6d. on the North-East Coast, 128s. in Sheffield, and 133s. 6d. in Birmingham, less 5s. per ton rebate.

LANCASHIRE.—While a few replacement orders have recently been negotiated, new business generally is at a standstill, and delivery arrears are considerable. Consumers continue to exert pressure for supplies, as, in some cases, operations are being restricted by the shortage. Some consumers are now using American foundry iron at 150s. to 155s., delivered this district. Offers of Derbyshire and Staffordshire brands of No. 3 foundry iron are on the basis of 109s. for deliveries in the Lancashire price zone, with Northants at 107s. 6d. and Derbyshire forge iron at from 104s. to 106s. West Coast hematite is quoted at 131s. and East Coast material at 130s. 6d. Scottish No. 3 is at 137s. 6d. per ton.

MIDLANDS.—The delivery position is fairly satisfactory as far as this district is concerned, and works are able to maintain a good rate of output. A still heavier demand is likely to be received in the autumn, and if this matures it is certain that a serious shortage will again be met. Supplies of forge iron are quite inadequate to meet current inquiries and the outlook over the winter months is anything but happy, as the demand is sure to increase. Special iron, at £6 10s. to £7 5s., is in active request and the condition of supply is such that consumers may soon be compelled to seek their requirements on the Continent. Refined iron is quoted at a minimum of £8 2s. 6d. per ton. Outputs of hematite have been fully disposed of up to the end of September, and, in many cases, up to the end of the year.

SCOTLAND.—There is heavy pressure for deliveries, and users would willingly take up larger tonnages if they could be procured. But producers are fully booked up for as far as they care to commit themselves. No. 1 foundry iron is quoted at 115s. 6d., with No. 3 foundry at 113s., f.o.t. furnaces. No Cleveland iron is entering the district and thus the prices of 104s. f.o.t. Falkirk and 107s. f.o.t. Glasgow for No. 3 iron are purely nominal. The steelworks are working to capacity. Prices of steel-making irons are as follow:—Mixed numbers of hematite, 123s.; Scottish basic, 107s. 6d.; English and Indian basic, 100s., all less 5s. rebate, delivered steelworks here.

Coke

For delivery to Birmingham and district, best Durham coke is quoted at 51s. 6d. to 55s., and Welsh at from 52s. 6d. to 65s. per ton. Generally, business is restricted to contracts up to the end of December, although it is not the fault of consumers that bookings have not been made involving deliveries well after that date.

Steel

Business in steel is moving on a limited scale, as it is difficult to place orders for steel for delivery this year, says the official report of the London Iron and Steel Exchange. The holiday stoppages in the manufacturing districts also contribute to the quiet appearance of the markets, although so urgent is the demand for all descriptions of steel that contrary to custom, few consumers are suspending deliveries. A severe stringency still exists in the semi-finished steel department, but lately some relief has been occasioned by imports of Continental steel and more regular deliveries from the British manufacturers. The position as regards finished materials is similar to that ruling in other departments of the steel trade. An enormous demand exists, only part of which can be satisfied, although the makers are endeavouring to ease the situation by concentrating upon urgently required work. The tonnage of material available for export remains limited in view of the urgent home requirements.

Scrap

Perhaps one of the chief reasons for the apparent success of the quest for iron and steel scrap has been the manner in which the public generally has co-operated with officialdom. The latest moves have included the enrolment of the aid of the Boy Scouts and the suggestion has been put forward that as coal merchants' vehicles usually return to the depôt empty they might be used to transport scrap material. An air tour of the larger centres has been undertaken by representatives of the British Iron and Steel Federation with a view to estimating the progress made and the planning of future schemes. After contract deliveries have been met, there is little surplus material available in most districts. Foreign scrap is being used in increasing tonnages. Prices remain firm.

Metals

An easier tone generally has prevailed on the non-ferrous metal markets during the past week, following a short period of speculative interest. The outlook would seem to be set fair for a period of stable business.

Copper.—Trade demand continues to involve only a small tonnage, but this is not unusual at this time of the year. There is as yet no change in the domestic copper quotation in the United States, although the export price is now 14.25 cents, against 14.45 cents previously. The threat of an increase in price was largely responsible for the recent spurt in demand. More than one-third of the total domestic sales in July was booked between July 27 and the last day of the month. Consuming industries generally are working to capacity and it is anticipated that the consumption of copper and cupreous alloys will reach high-record levels during the current year.

The United States Copper Institute reports that the world's refined copper stocks for July amounted to 313,110 short tons, as compared with 300,445 tons in June and 432,322 tons in July, 1936. There was thus a rise of 12,665 tons on the month. World apparent consumption was lower by 9,080 tons. The July total was 180,600 tons, as compared with 189,680 tons in June, and 146,042 tons in July, 1936.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £57 16s. 3d. to £57 17s. 6d.; Friday, £57 12s. 6d. to £57 15s.; Monday, £57 3s. 9d. to £57 6s. 3d.; Tuesday, £57 2s. 6d. to £57 5s.; Wednesday, £57 1s. 3d. to £57 3s. 9d.

Three Months.—Thursday, £57 18s. 9d. to £58; Friday, £57 16s. 3d. to £57 17s. 6d.; Monday, £57 7s. 6d. to £57 8s. 9d.; Tuesday, £57 3s. 9d. to £57 5s.; Wednesday, £57 2s. 6d. to £57 5s.

Tin.—Quieter conditions have ruled in this market recently. In the United States, output of tinplates in the first seven months of the year is estimated at 36,600,000 base boxes, against 30,900,000 boxes in the corresponding period of last year. It is reported by the Malayan Information Agency that the total production of tin for Malaya in July was 5,665 tons. The output quota is 6,594 tons. The prolonged drought is held responsible to a large extent for the low production. The world's mining output of tin in May, according to the Metallgesellschaft, was 15,914 metric tons, against 15,585 tons in April. The January-May total at 79,546 tons compares with 71,576 tons in the corresponding period of last year.

Official quotations were as follow :—

Cash.—Thursday, £265 10s. to £265 15s.; Friday, £268 15s. to £269; Monday, £265 5s. to £265 10s.; Tuesday, £266 15s. to £267; Wednesday, £265 to £265 5s.

Three Months.—Thursday, £263 10s. to £263 15s.; Friday, £267 to £267 5s.; Monday, £263 15s. to £264; Tuesday, £264 15s. to £265; Wednesday, £263 10s. to £263 15s.

Spelter.—This market also has relaxed somewhat and conditions have been steadier. Chief interest at the present time is centred in the position of the metal in the United States. Producers there are quite unable to cope with the inquiry, and consumers have been forced to seek the metal elsewhere. Large tonnages have been booked with European sellers and it is now reported that Canadian producers are shipping Canadian refined electrolytic zinc of high purity to the United States for the first time for many years, and despite the fact that there is a tariff of 1¼ cents per pound on zinc entering the United States. There are no zinc stocks in Canada at the present time.

Daily market prices :—

Ordinary.—Thursday, £24 7s. 6d.; Friday, £24 10s.; Monday, £24 7s. 6d.; Tuesday, £24 5s.; Wednesday, £24 1s. 3d.

Lead.—More normal conditions have returned to this market. No increase in demand is likely until the autumn. Facts regarding the building industry which have just been published by the Special Committee for Public Relations of the Building Industries National Council show that, while the boom is being fully maintained, one of the chief problems in the building industry is the shortage of structural steel. The council point out, however, that there has been a considerable change-over to alternative methods of construction, and every effort will be made by this means to reduce the demand for steel to a minimum while present difficulties last. The American Bureau of Metal Statistics announces that the world's output of lead in June (excluding Spain) was 147,157 short tons, as compared with 157,930 tons in the previous month.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £23; Friday, £22 16s. 3d.; Monday, £22 13s. 9d.; Tuesday, £22 8s. 9d.; Wednesday, £22 7s. 6d.

Scrap.—There is little indication as yet of any real improvement in the demand for non-ferrous scrap metal. Higher quotations are expected to rule when the autumn buying movement commences. Copper and zinc prices already have shown small increases.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £43; foil, £94 to £98. Copper, £54 to £58; braziery, £51. Brass (clean), £33 to £36. Zinc, £16. Lead, £22 10s. Gunmetal, £52 to £54.

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Alloy designation	Chief alloying metals	Form of test specimen	Proof stress tons/sq. in.	Com. mercial elas. limit tons/sq. in.	Ult. tensile strength tons/sq. in.	Elongation % on 2"	Brinell hardness
3L5	2½–3% Cu. 12½–14½% Zn.	Sand cast	3·5– 4·0	5·0– 6·0	9·0–11·0	2·0– 4·0	60– 65
		Chill cast	3·5– 4·0	6·0– 7·0	11·0–14·0	3·0– 8·0	65– 70
4L11	6 –8% Cu.	Sand cast	3·5– 4·0	5·5– 6·5	7·5– 9·0	1·5– 2·5	60– 70
		Chill cast	3·5– 4·0	6·0– 7·0	9·0–11·5	3·0– 5·0	65– 70
3L8	11 –13% Cu.	Sand cast	4·5– 5·0	6·0– 7·0	7·0– 8·0	0· – 1·0	75– 90
		Chill cast	4·5– 5·0	7·0– 8·0	9·0–11·0	0· – 1·5	80– 90
BA/40D	10 –13% Si.	Sand cast, modified	3·5– 4·0	5·0– 6·0	10·5–11·0	5·0– 8·0	50– 55
		Chill cast, modified	4·0– 4·5	5·5– 6·5	13·0–14·0	8·0–15·0	55– 60
BA/40J	7½–8½% Si.	Sand cast	3·0–3·25	4·25–4·5	9·0–10·0	6·0–11·0	45– 47
		Chill cast	3·0–3·25	4·5– 5·0	11·0–12·0	13·0–20·0	55– 60
CS/16	4% Cu., 3% Si.	Sand cast	3·0– 3·5	5·0– 5·5	8·0– 9·0	2·0– 3·0	70– 75
		Chill cast	3·0– 3·5	5·0– 5·5	10·5–12·5	6·0– 9·0	80– 85
"Y" alloy	4% Cu., 2% Ni. 1½% Mg.	Sand cast, heat-treated	13·0–14·0	13·0–14·0	14·0–15·0	1·0– 2·0	95–105
		Chill cast, heat-treated	14·0–15·6	16·0–18·0	18·0–20·0	2·0– 4·0	95–105
BA/23	1½% Mg.	Sand cast, heat-treated	10·5–12·0	11·0–12·5	12·0–13·0	2·0– 3·0	70– 80
		Chill cast, heat-treated	11·5–13·6	12·0–13·5	16·0–17·5	12·0–20·0	80– 90
BA/40M	12% Si., 0·4% Mn. 0·3% Mg.	Sand cast, heat-treated	13·0–15·5	15·0–16·5			
		Chill cast, heat-treated	16·0–18·0				
BA/5	5–6% Cu.	Sand cast, heat-t					

DATA FOR THE FOUNDRYMAN

Will be gladly sent on request

THE British Aluminium CO. LTD

Head Office: ADELAIDE HOUSE, LONDON, E.C.4. Telephone: Mansion House 5561 (6 lines). Telegrams: "Cryolite, London."

F.T.J. 19.8.37

RAW MATERIALS—PRICE LIST

(Wednesday, August 18, 1937)

COPPER

	£	s.	d.
Standard cash	57	1	3
Three months	57	2	6
Electrolytic	63	0	0
Rough	62	5	0
Best selected	62	15	0
Sheets	95	0	0
India	73	15	0
Wire bars	64	0	0
Ingot bars	64	0	0
H.C. wire rods	67	10	0
Off. av. cash, July	56	9	4 7/44
Do., 3 mths., July	56	8	2 9/11
Do., Sttlmnt., July	56	9	2 9/11
Do., Electro, July	63	10	2 9/11
Do., B.S., July	63	12	6
Do., wire bars, July	64	4	3 9/11
Solid drawn tubes			14½d.
Brazed tubes			14½d.
Wire			10½d.

BRASS

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10⅜d.
Wire	10½d.
Rolled metal	9⅞d.
Yellow metal rods	7⅜d.

TIN

	£	s.	d.
Standard cash	265	0	0
Three months	263	10	0
English	265	0	0
Bars	270	10	0
Straits	270	5	0
Eastern	266	12	6
Banca (nom.)			—
Off. av. cash, July	263	14	1 1/11
Do., 3 mths., July	262	6	8 4/11
Do., Sttlmt., July	263	14	2 1/11

SPELTER

	£	s.	d.
Ordinary	24	1	3
Remelted	21	0	0
Hard	20	0	0
Electro, 99.9	26	13	9
English	25	5	0
India	21	0	0
Zinc dust	30	0	0
Zinc ashes	7	12	6
Off. aver., July	22	12	7 1/11
Aver. spot, July	22	11	4 4/11

LEAD

	£	s.	d.
Soft foreign, ppt.	22	7	6
Empire (nom.)	23	5	0
English	24	10	0
Off. aver., July	23	16	4 17/22
Aver. spot, July	23	18	7 7/11

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.	£	s.	d.
Zinc sheets, English	37	10	0 to	38	0	0
Do., V.M. ex-whse.	37	10	0 to	38	0	0
Rods				33	0	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	82	10	0 to	83	10	0
Chinese, ex-whse.				75	0	0
Crude, c.i.f.					—	

QUICKSILVER

	£	s.	d.
Quicksilver	13	10	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£14 10 0
45/50%	£12 0 0
75%	£17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	6/3 lb.
Tungsten metal powder—	
98/99%	6/4½ lb.
Ferro-chrome—	
2/4% car.	£34 15 0
4/6% car.	£24 5 0
6/8% car.	£24 0 0
8/10% car.	£24 0 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£38 5 0
Max. 0.5% car.	£41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 7d.
Finished bars, 18% tungsten	3s. 6d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales (West)—	£	s.	d.	£	s.	d.
Heavy steel, best	3	7	6 to	3	10	0
Mixed iron and steel	3	5	0 to	3	7	6
Heavy cast iron	3	8	0 to	3	10	0
Good machinery				4	0	0
Cleveland—						
Heavy steel, best	3	6	6 to	3	9	0
Steel turnings				2	15	0
Heavy cast iron				4	7	6
Heavy machinery				4	10	0
Midlands—						
Short heavy steel	3	17	6 to	4	0	0
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	2	6 to	2	5	0
Scotland—						
Heavy steel, best	3	4	6 to	3	7	0
Ordinary cast iron	4	5	0 to	4	7	6
Cast-iron borings	2	0	0 to	2	2	6
Wrot-iron piling	4	15	0 to	4	17	6
Heavy machinery	4	12	6 to	4	15	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	48	0	0
Brass	31	0	0
Lead (less usual draft)	18	10	0
Tea lead	13	10	0
Zinc	16	0	0
New aluminium cuttings	72	0	0
Braziery copper	43	0	0
Gunmetal	46	0	0
Hollow pewter	175	0	0
Shaped black pewter	130	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	103/6
,, No. 3	101/-
,, No. 4	100/-
Forge No. 4	100/-
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	103/-
,, No. 3 fdry.	106/-
Northants forge	100/6
,, fdry. No. 3	103/6
,, fdry. No. 1	106/6
Derbyshire forge	103/-
,, fdry. No. 3	106/-
,, fdry. No. 1	109/-
Scotland—	
Foundry, No. 1, f.o.t.	115/6
,, No. 3, f.o.t.	113/-
Cleveland No. 3, Glasgow	107/-
,, ,, Falkirk	104/-
Scottish hem. M/Nos. d/d	123/-*
Sheffield (d/d district)—	
Derby forge	100/6
,, fdry. No. 3	103/6
Lincs forge	100/6
,, fdry. No. 3	103/6
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	109/-
Staffs fdry. No. 3	109/-
Northants fdry. No. 3	107/6
Cleveland fdry. No. 3	109/-
Glengarnock, No. 3	137/6
Clyde, No. 3	137/6
Monkland, No. 3	137/6
Summerlee, No. 3	137/6
Eglinton, No. 3	137/6
Gartsherrie, No. 3	137/6
Shotts, No. 3	137/6

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ¼ in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ¼ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars					15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	14d.
Wire	15½d.
Rods	16d.
Tubes	20½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3⅝ to 1/9⅝
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	36/6
,, furnace	35/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	25/- to 26/-
,,	28×20 ,,	51/- to 52/-
,,	20×10 ,,	36/6 to 36/9
,,	18¾×14 ,,	26/3 to 26/6
C.W.	20×14 ,,	22/6 to 23/-
,,	28×20 ,,	46/- to 46/6
,,	20×10 ,,	32/- to 32/6
,,	18¾×14 ,,	23/- to 23/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£12	0	0 to	£13	0	0
Bars-hammered, basis	£20	0	0 to	£21	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to	£20	0	0
Blooms	£16	0	0 to	£17	0	0
Keg steel	£30	0	0 to	£35	0	0
Faggot steel	£20	0	0 to	£25	0	0
Bars and rods dead soft st'l	£19	0	0 to	£20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Aug.	12	57	16	3	dec.	18/9
,,	13 ..	57	12	6	,,	3/9
,,	16 ..	57	3	9	,,	8/9
,,	17 ..	57	2	6	,,	1/3
,,	18 ..	57	1	3	,,	1/3

Electrolytic Copper

		£	s	d		
Aug.	12 ..	64	10	0	dec.	20/-
,,	13 ..	64	0	0	,,	10/-
,,	16 ..	63	10	0	,,	10/-
,,	17 ..	63	10	0	No	change
,,	18 ..	63	0	0	dec.	10/-

Standard Tin (cash)

		£	s.	d.		
Aug.	12 ..	265	10	0	dec.	15/-
,,	13 ..	268	15	0	inc.	65/-
,,	16 ..	265	5	0	dec.	70/-
,,	17 ..	266	15	0	inc.	30/-
,,	18 ..	265	0	0	dec.	35/-

Tin (English ingots)

		£	s.	d.		
Aug.	12 ..	265	10	0	dec.	20/-
,,	13 ..	268	15	0	inc.	65/-
,,	16 ..	265	5	0	dec.	70/-
,,	17 ..	266	15	0	inc.	30/-
,,	18 ..	265	0	0	dec.	35/-

Spelter (ordinary)

		£	s.	d.		
Aug.	12 ..	24	7	6	dec.	15/-
,,	13 ..	24	10	0	inc.	2/6
,,	16 ..	24	7	6	dec.	2/6
,,	17 ..	24	5	0	,,	2/6
,,	18 ..	24	1	3	,,	3/9

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Aug.	12 ..	27	0	0	dec.	16/3
,,	13 ..	27	5	0	inc.	5/-
,,	16 ..	27	0	0	dec.	5/-
,,	17 ..	26	17	6	,,	2/6
,,	18 ..	26	13	9	,,	3/9

Lead (soft foreign, prompt)

		£	s.	d.		
Aug.	12 ..	23	0	0	inc.	5/-
,,	13 ..	22	16	3	dec.	3/9
,,	16 ..	22	13	9	,,	2/6
,,	17 ..	22	8	9	,,	5/-
,,	18 ..	22	7	6	,,	1/3

Lead (English)

		£	s.	d.		
Aug.	12 ..	25	0	0	No	change
,,	13	25	0	0	,,	,,
,,	16 ..	24	15	0	dec.	5/-
,,	17 ..	24	10	0	,,	5/-
,,	18 ..	24	10	0	No	change

Imports and Exports of Pig-iron, Castings, etc., in July and the Seven Months 1937, compared with July and the Seven Months 1936.

	July.		Seven months.		July.		Seven months.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	9,687	14,679	54,186	105,251	30,562	53,992	169,339	385,542
,, ,, Other British Countries	—	6,315	—	19,106	—	32,345	—	89,453
,, ,, Foreign Countries	10,235	66,249	31,254	140,887	29,598	407,697	127,867	812,198
Total	19,922	87,243	85,440	265,244	60,160	494,034	297,206	1,287,193
Castings and forgings	347	320	4,664	1,581	15,402	10,624	160,821	49,441
Cast pipes and fittings	253	208	837	738	7,460	4,651	28,333	19,721
Stoves, grates, etc.	161	60	505	401	9,929	5,707	47,896	48,909
Baths	1,030	808	4,257	5,813	23,661	20,172	105,327	141,781
Hollow-ware, all kinds	331	372	2,078	2,194	17,578	20,717	113,067	128,741
Exports.								
Pig-iron, forge and foundry	5,367	5,756	32,828	56,617	20,542	35,722	124,370	292,254
,, acid	6,141	6,166	22,446	36,005	24,040	36,308	80,901	191,405
,, basic	—	1	108	517	—	6	557	3,072
Total	11,508	11,923	55,382	93,139	44,582	72,036	205,828	486,731
Castings and forgings	305	266	2,427	2,045	12,604	10,959	92,331	78,503
Cast pipes and fittings, up to 6 in. diameter	5,371	5,284	32,213	35,490	58,827	64,705	361,822	391,080
,, ,, ,, over 6 in. ,,	3,559	7,215	23,918	28,330	28,733	55,002	195,154	222,632
Stoves, grates, etc.	778	854	5,740	6,778	40,872	48,807	295,864	363,572
Sanitary cisterns	289	289	1,793	2,152	8,430	10,777	55,817	71,478
Bedsteads, including tubes therefor	419	577	2,801	3,598	15,885	22,107	105,378	135,859
Hollow-ware	541	486	3,199	3,150	19,958	17,196	114,697	110,704

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

CHEMIST (26), 4½ years non-ferrous assaying, all alloys, seeks situation with prospects. Inter. B.Sc. B.Sc.(Met.) student. London area preferred.—Write: J. M., 8, Royston Gardens, Ilford, Essex.

FOUNDRY Foreman desires change. A thoroughly practical man with technical knowledge and an all-round experience in engineering, repetition, and machine-moulded castings. Cupola and metal control.—Box 516, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

DRAUGHTSMAN REQUIRED. Must be fully conversant with Conveyor mechanisation of foundries.—Reply Box 504, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman, having experience in green and dry sand, and with jolting machines on repetition work. North Staffordshire district. Apply, stating age, experience and salary required, to: Box 530, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager required by large Iron and Steel Founders in India. Applicants should be of good education and competent to take complete control of large jobbing Iron and Steel Foundries. They should have had experience of office routine and be able to assume control of a departmental office. Salary about £67 per month, but according to qualifications; five-year agreement, free passages, provident fund and home leave on re-engagement. Apply by letter, with copies of testimonials, stating age and whether married or single to: Box 508, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PLANT ENGINEER required for maintenance and erection of new plant. Applicants must state age, salary required, and experience in electrically-driven—

(*a*) Mechanical Continuous Casting Plants and Cupolas.
(*b*) Air Compressors.
(*c*) Hydraulic Moulding Plant.
(*d*) Power Presses, Welding, etc.
(*e*) Porcelain Enamelling.
(*f*) Stove Enamelling.
(*g*) Sand-blast Plant.
(*h*) General Engineering.
(*i*) Building Maintenance.

SIDNEY FLAVEL & CO., LTD.,
Stove, Grate and Gas Stove Manufacturers,
LEAMINGTON.

SALES Engineer, young, but with experience in metallurgical plant, preferably electric furnaces and equipment, required to travel, follow up inquiries, service, etc. Progressive position offered. Applicants must give age, details of experience, positions held, and salary required. No applicants considered without these details. Write in confidence to: Box 528, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Foundry Manager, age 30-45, for large mechanised Jobbing Foundry in London. Applications only entertained from men of exceptional ability. Strict disciplinarian, must be able to obtain high production of first class castings. Permanent job, high salary.—Box 534, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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